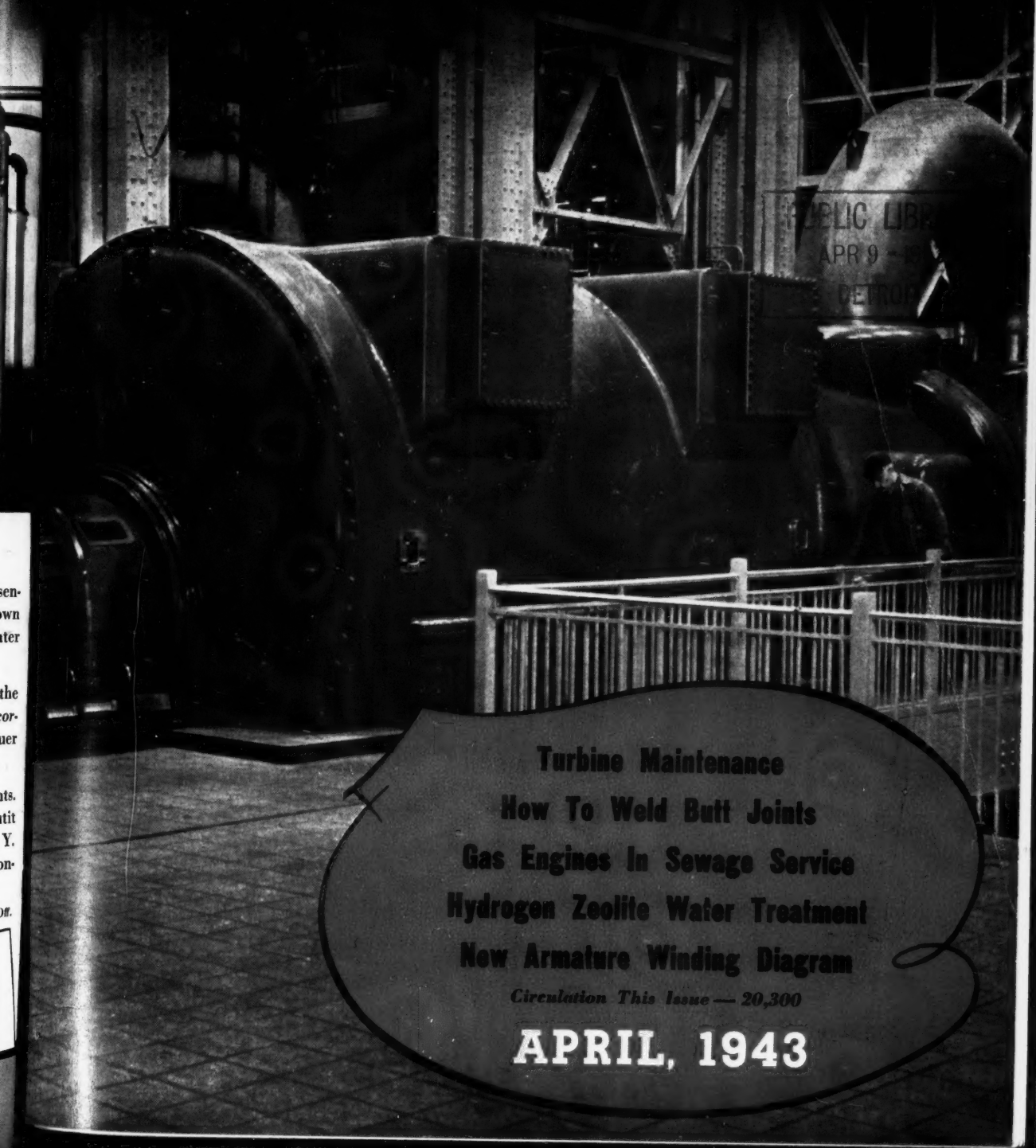
POWER PLANT ENGINEERING

THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY



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Turbine Maintenance

How To Weld Butt Joints

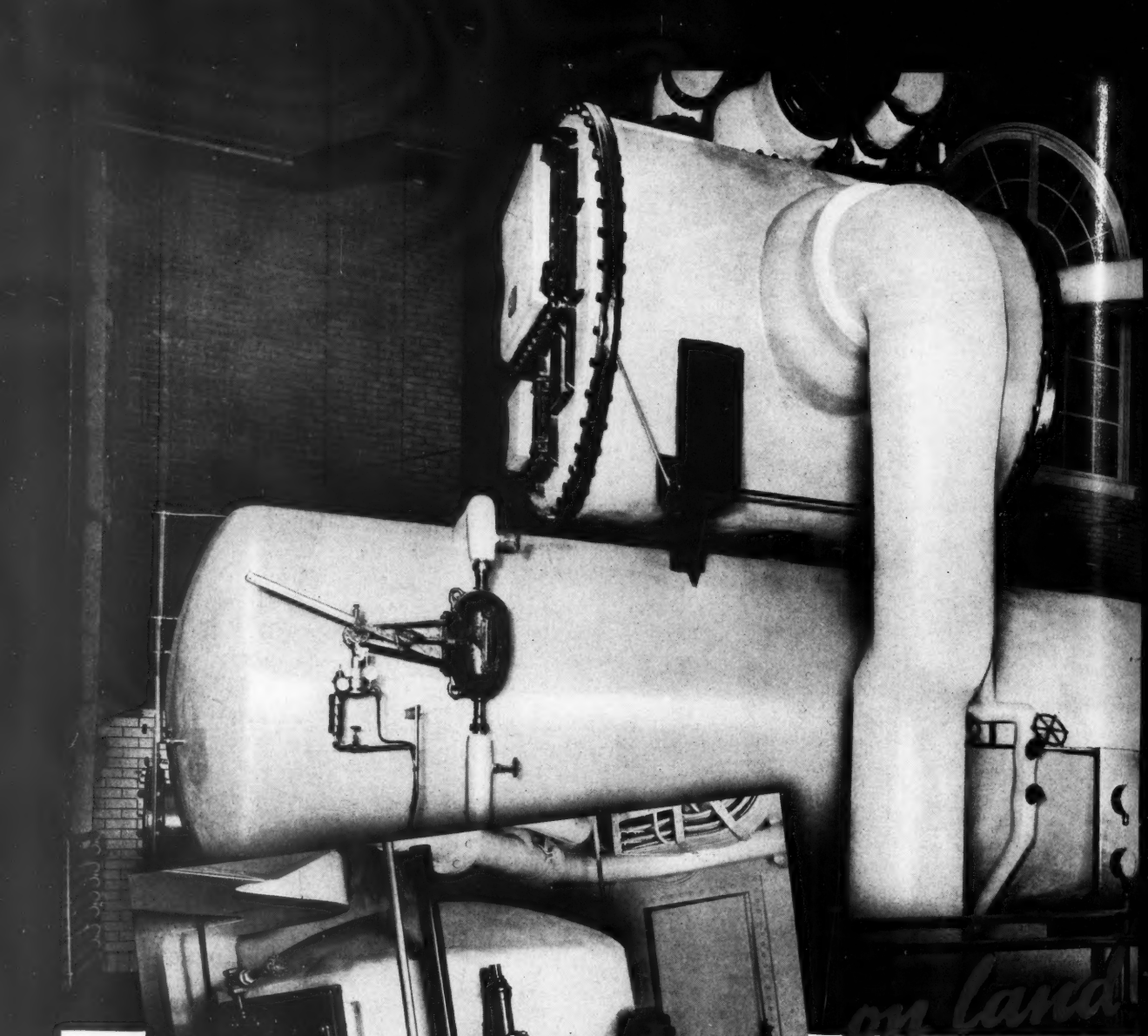
Gas Engines In Sewage Service

Hydrogen Zeolite Water Treatment

New Armature Winding Diagram

Circulation This Issue — 20,300

APRIL, 1943



on land

Above—*Elliott 453,100-lb.-per-hr. horizontal, cast iron deaerating feedwater heater mounted on a 6,000 gal. steel storage tank. This unit was built for a central station using materials most readily available at the time in order to make the quick shipment needed.*

and sea

At left—*Typical installation of an Elliott marine type deaerating feedwater heater. Hundreds of these units are today serving America's sea-going power plants. They are built to operate efficiently under the special conditions of marine service.*

ELLIOTT *pioneered* DEAERATIO

Corrosion is an AXIS ally
– *defeat it with*

ELLIOTT

DEAERATING
FEEDWATER HEATERS

Twenty-three years ago Elliott engineers perfected the idea of removing dissolved oxygen from feedwater, thus defeating corrosion troubles in boilers, economizers, piping, etc. Deaeration has since become an accepted power plant principle and nearly all plants make provision for proper deaeration as a part of the feedwater heating cycle.

For service on land or on sea, the seasoned experience of Elliott engineers is helping designers select the proper type and size of deaerating unit, equipped with the desired water storage and controls, to fit into the heat balance scheme, and to meet any installation or space conditions.

If you have a problem of deaerating and heating feedwater, use the expert cooperation of Elliott engineers.

ELLIOTT COMPANY

DEAERATOR AND HEATER DEPARTMENT, **JEANNETTE, PA.**

DISTRICT OFFICES IN PRINCIPLE CITIES

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nd is still breaking the trail

...from your veterans

HUNDREDS of America's veteran steam engines are again going into active service . . . answering America's call for more wartime power.

Whatever the operating temperature or pressure in your plant, you can be assured of maximum power output from your reciprocating steam engines, old or new, by lubricating them with *Texaco Steam Cylinder Oil.*

Properly selected *Texaco Steam Cylinder Oils* atomize completely, adhere to cylinder walls, separate rapidly from the exhaust; assure quiet operation and low oil consumption.

So effective have Texaco Lubricants proved that they are definitely preferred in many other important fields, a few of which are listed in the panel.

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★ ★ ★

The Texas Company, 135 East 42nd Street, New York, N. Y.

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★ More buses, more bus lines and more bus-miles are lubricated and fueled with Texaco than with any other brand.

★ More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.

★ More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.

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TEXACO Steam Cylinder Oils

FOR EVERY STEAM CONDITION

TUNE IN FRED ALLEN EVERY SUNDAY NIGHT—CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY

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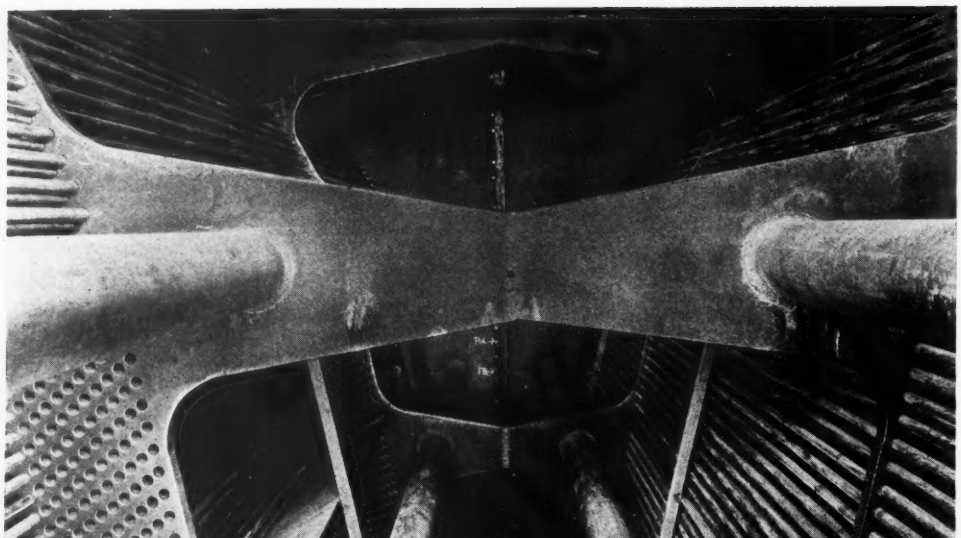
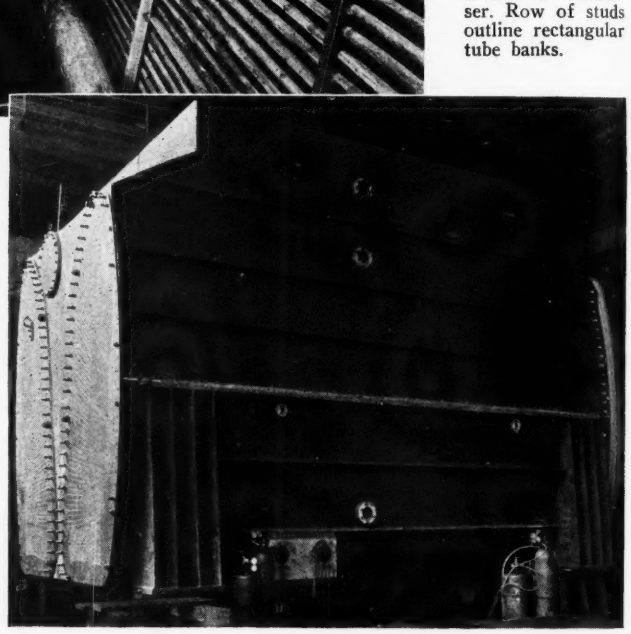


Left—Large central steam space dividing condensing tubes into two shallow banks.

Below—40,000 sq. ft. single pass cross-flow condenser. Row of studs outline rectangular tube banks.



CROSS FLOW CONDENSER

HIGH-VACUUM -LOW CONDENSATE DEPRESSION

Efficient condenser performance depends primarily on maintenance of high vacuum and low condensate depression. Foster Wheeler cross-flow construction achieves these objectives through design characteristics:

1. Large central steam space provides effective steam distribution over condensing surface. Considerable steam is at once condensed, thus reducing velocity and pressure drop through remainder of tube bank. This open steam circulation also effects positive heating of condensate. Length of steam travel to and through shallow tube banks is shortened, affording easier, quicker condensation.
2. There are no dead zones and no overloaded zones. Tubes are spaced on straight lines converging in the direction of steam flow thus maintaining a steadier steam velocity and equalizing pressure drops throughout.
3. Condensate is drained off outside of tube areas by sloping baffles parallel to steam flow. This prevents excessive cooling of condensate, which otherwise would fall through tube bank, clogging the area with resultant increase in pressure drop and decrease in heat transfer.

FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW YORK, N. Y.

FOSTER WHEELER

FRONT LINES

TALK about little-known occupations! At dinner in a Chicago restaurant the other night, we had to listen to the conversation of six women at an adjoining table. To our perverted sense of humor their discussion got funnier and funnier the more we thought about it. They were teachers—of square dancing—to the feebleminded! 'S a fact, so help us! It requires a special technique, too. There are some figures of square dances that you don't dare teach the feebleminded. Apparently these rouse all their baser instincts. And then they lose track of their partners, which makes them nuttier than ever!

GREASEMAN, don't grab the water hose when bearings are running hot! Instead do the correct things with lubrication and the bearing itself, says Frank Forrest of Allis-Chalmers in the February issue of Victory Production & Maintenance News. This publication also calls attention to Allis-Chalmers' valuable book on wartime care of centrifugal pumps, recently noted in our catalog section. The bulletin also carries some interesting illustrations showing commutator maintenance methods and discusses why an oil atmosphere is no spot to apply a standard cage motor. Incidentally, it points out that the U. S. war production peak is still months away. That means that war production machines will run as many as 8700 hours in 1943, quadrupling the normal 1800 in peacetime. That in turn means you owe your machines quadrupled maintenance.

THE new steels will work miracles in industry when peace returns, says R. W. Roush of The Timken-Detroit Axle Co. They have been astoundingly effective in detouring successive shortages of nickel, chromium, manganese, vanadium, tungsten, molybdenum and other alloys. New properties and characteristics of old materials, as well as new materials, are being discovered, according to Wood and Sanders of General Motors' Chevrolet Division. Discovery of one substitute is insufficient since expanding use immediately creates new shortages. Despite Japan's blockade of the world's supply of tin, several satisfactory substitutes have been developed, including lead-base babbitts containing arsenic and silver, according to L. M. Tichvinsky of the U. S. Naval Engineering Experiment Station.

GETTING more out of less—American industry's favorite sport. Instead of sending scrap in the form of drop-offs or unused ends from busbars or quarter-inch copper bar stock back to the foundry, G-E Co. now saves all pieces with an area of 4 sq. in. or more, separates odd-size pieces for making washers and spacers, and retains regular sizes for use in making larger parts. Thus an annual saving of 125,000 lb. of new bar copper stock is expected. Similarly, carbon panel steel scrap from the primary shearing operations is accumulated and sorted and all pieces over 50 sq. in. are saved. These are used in producing a large number of various small parts. Thus 40,000 lb. of such sorted scrap were used in a recent six weeks period and it is estimated that 800,000 lb. will be saved annually in this item alone, and possibly more with finer sorting. Along the same line, Sloan Valve Co., by redesigning a toilet flush valve to substitute plastics and malleable iron for brass, reduces its copper content from 6 lb. to 4 oz. per valve, saving 4,400,000 lb. of copper at present production rates—enough to make 70,500,000 30-cal. cartridge cases.

WHEN YOU UNWRAPPED this issue, probably the first things you noticed were the slightly smaller dimensions and the different type of binding. The paper stock is also somewhat lighter in weight but is of higher quality and has a better printing surface. But you will also notice that you get the same amount of editorial material as usual. It just weighs less.

You guessed it. These changes are made as a result of the WPB order requiring all publications using 100 t. or more of paper per year to reduce paper consumption 10 per cent.

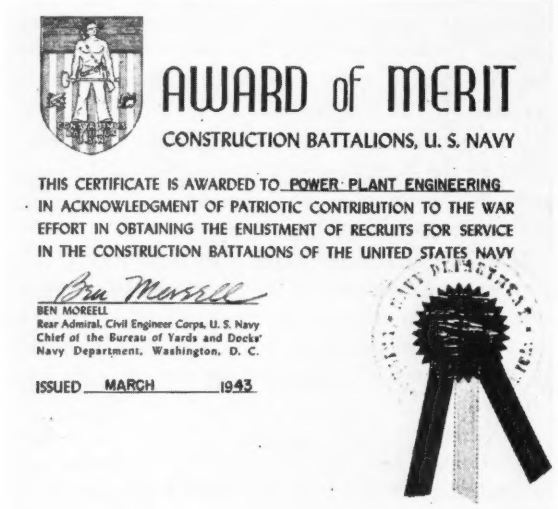
With an increasing number of subscribers, rapidly growing advertising volume, and more important information to be transmitted to readers, it has been a real puzzle to work out ways of reducing paper use without curtailing service in any department.

Power Plant Engineering has effected more than the required reduction in paper purely through streamlining. We cut the size from 8¾ by 11⅝ in. to 8⅛ by 11¼ in. *without reducing the amount of printing per page.* We saved part of the margin by using a "saddle-stitched" binding, so that each page opens up to its full width. Incidentally, this style of binding makes the book easier to handle and read. It opens flat and stays open. It makes clipping easier, too. We reduced the weight of paper stock but actually improved printing by using a different, more expensive kind of paper.

Further paper cuts are doubtless coming—another 10 per cent is expected in July—but we have plans to meet them without impairing any vital service to readers. You may notice less white space, fewer frills, but all the real engineering information you need will be published in the complete detail to which you have so long been accustomed in Power Plant Engineering.

Incidentally, don't let the changed appearance of this April issue fool you. It may look a little smaller but actually it's a *bigger* issue—194 pages. Twenty-two pages bigger than March!

DO YOU make capital of the fact that you cannot publish or issue information about secret developments and products you are making for the war program? If not, take a tip from General Radio Co. It is taking this opportunity to present, in the January and February, 1943, issues of its monthly Experimenter, a very interesting, easy-to-read, but authoritative series of articles entitled "The Noise Primer." We're planning to publish some of this information in a future issue. Part III is about the finest thing we have seen on The Decibel—What Is It? For example, do you know why you cannot add decibels? This tells you. Part IV gives operating instructions and other practical details on how to use a sound level meter. Incidentally, another article in the January issue gives a discussion of substitute batteries for battery operated equipment. Many manufacturers of power plant equipment are already doing this type of thing, as we have previously pointed out. But some are not. Here are some valuable tips for them on how to tackle the job.



AWARD of MERIT

CONSTRUCTION BATTALIONS, U. S. NAVY

THIS CERTIFICATE IS AWARDED TO POWER PLANT ENGINEERING IN ACKNOWLEDGMENT OF PATRIOTIC CONTRIBUTION TO THE WAR EFFORT IN OBTAINING THE ENLISTMENT OF RECRUITS FOR SERVICE IN THE CONSTRUCTION BATTALIONS OF THE UNITED STATES NAVY

Ben Moreell

BEN MOREELL
Rear Admiral, Civil Engineer Corps, U. S. Navy
Chief of the Bureau of Yards and Docks
Navy Department, Washington, D. C.

ISSUED MARCH 1943

A NUMBER of people have reprimanded us severely for saying in the last issue, "One of the proudest statistics that the publishing business is of." To our amazement, they had never heard of Florian Slappy's classic comment: "Po'k chops is de fondest thing Ah is of!" Also they had never heard of the little boy who said to his very small brother: "What did you bring me that book to be read to out of for?" Also, they—aw, what's the use!

THE first of the two hydroelectric generating units originally constructed for Shasta Dam of the Central Valley project in California, and later transferred to the Grand Coulee Dam, has just gone into operation, adding more than 70,000 kw. to the generating capacity available for war industries of the Pacific Northwest. The two units transferred will be replaced at Shasta by two others of equal size to go into operation in 1944 and will be returned to Shasta at some future date.

REDUCTION of 74 per cent in models and sizes of portable construction concrete mixers, truck mixer-agitators and contractors' dewatering pumps is expected to result from simplification imposed on manufacturers of that equipment under L-217.

EXISTENCE of the Combined Raw Materials Board, created a year ago by President Roosevelt and Prime Minister Churchill, may provide some part of the foundation for settlement of the world-wide scramble for raw materials that is bound to occur after the war ends, says William L. Batt, Vice Chairman of the War Production Board. Operations of the board in the past year, Mr. Batt said, aided immeasurably in "bringing order out of what might have been chaos" on the raw materials front, which stretches around the world and supplies the life-blood of war production. Positive action has been taken to bring about a planned utilization of world supplies to the essential war needs of the United States. Mr. Batt, American member of the board, made public a report sent to the President by WPB Chairman Donald M. Nelson on the first year of operations. A similar report will be available to Mr. Churchill through the British Minister of Production to whom the British member, Sir Clive Baillieu, submits his report. This report is talking about things that are going to affect every detail of your life for a long time to come. We suggest that you get a copy and read it.

DRUMS—steel drums—every engineer is urged to cooperate in keeping them in good condition and returning them promptly. The Houghton Line, discussing the necessity for this, also says that old-fashioned wooden barrels need more care than they get. Incidentally, in returning old drums don't forget to send along bung plugs, gaskets, lids and locking rings, for these are as difficult to replace as the drums themselves. Nobody can ship liquids in a paper bag.

PRODUCTION of steel gears without machining, one of the most revolutionary new manufacturing methods evolved in years, was revealed in Milwaukee this month at the national war production meeting of the American Society of Tool Engineers. The process is already being applied to the production of pinion gears for military vehicles.

THE war program, twice expanded since 1939, now provides for nearly 100 times the 3350 t. of magnesium produced in that year, says Philip D. Wilson, Chief of Production, Aluminum and Magnesium Division, WPB. The goal announced by the WPB in February, 1942, was 362,500 t. per year. Because of the development during the year of satisfactory types of incendiary bombs other than magnesium, this objective has been somewhat reduced but the capacity of plants already built or under construction will be huge.

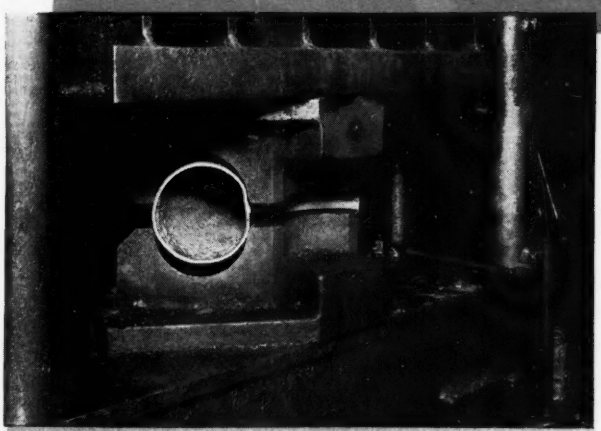
HAVE you noticed recently a slight change in the color of new five-cent coins? The fact is that the familiar nickel no longer contains nickel. As in many other cases, use of nickel in coinage has had to give way to more urgent military needs. Also, have you seen the new zinc-coated pennies? There are some complaints that they turn black.

DISCOVERY that gas dissolves in certain metals just as salt dissolves in water may lead to the production of longer-lasting electronic tubes which will require less power to operate, according to Dr. Harvey C. Rentschler, physicist of Westinghouse.

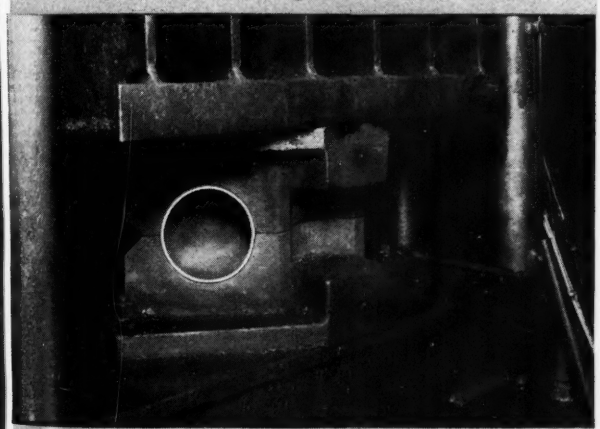
MIDWEST

BUTT-WELDING ELBOWS

Have Greater Dimensional Accuracy and Uniformity



(Above) Oversize Midwest Elbow has been reheated and placed in sizing die for reduction to exact size and shape. Dies have just started to compress 8" elbow having circumference ½" greater than when finished.



Showing the sizing operation completed. The Midwest Welding Elbow now has true circular cross section, uniform wall thickness, and accurate radius, included arc and tangents.

Because

They are SIZED IN COMPRESSION

This exclusive Midwest feature is very important to all users of welding elbows because it (1) saves time (and therefore money) in lining up pipe and elbow, (2) saves welding time, and (3) assures more uniform welds.

This feature results from the unique process for manufacturing Midwest Welding Elbows. The Midwest Elbow is first made slightly oversize . . . it is then reheated and reduced to accurate size and shape by a final working of the metal in *compression* at a forging heat—it is not extruded or stretched.

This feature applies to all Midwest Welding Elbows—both American Standard and "Long Tangent." See Bulletin WF-41 for details regarding the many other advantages of Midwest Welding Fittings.

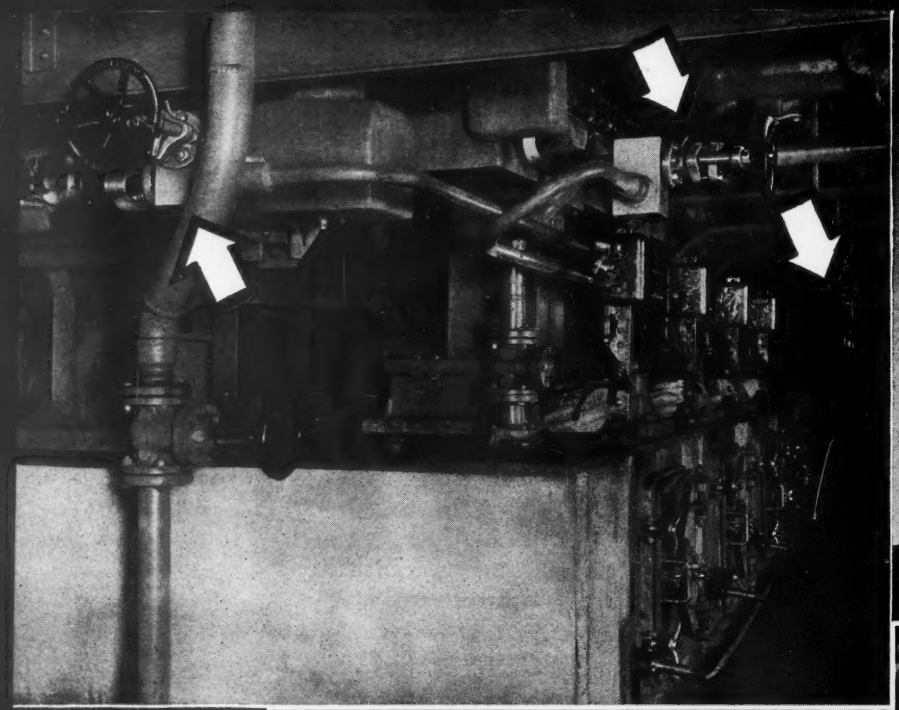
MIDWEST PIPING & SUPPLY CO., INC.

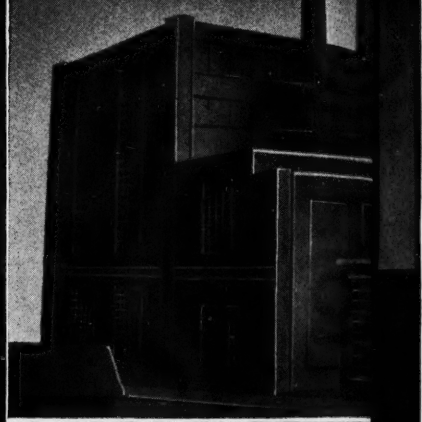
Main Office: 1450 S. Second St., St. Louis, Mo.
Plants: St. Louis, Passaic (N.J.) and Los Angeles

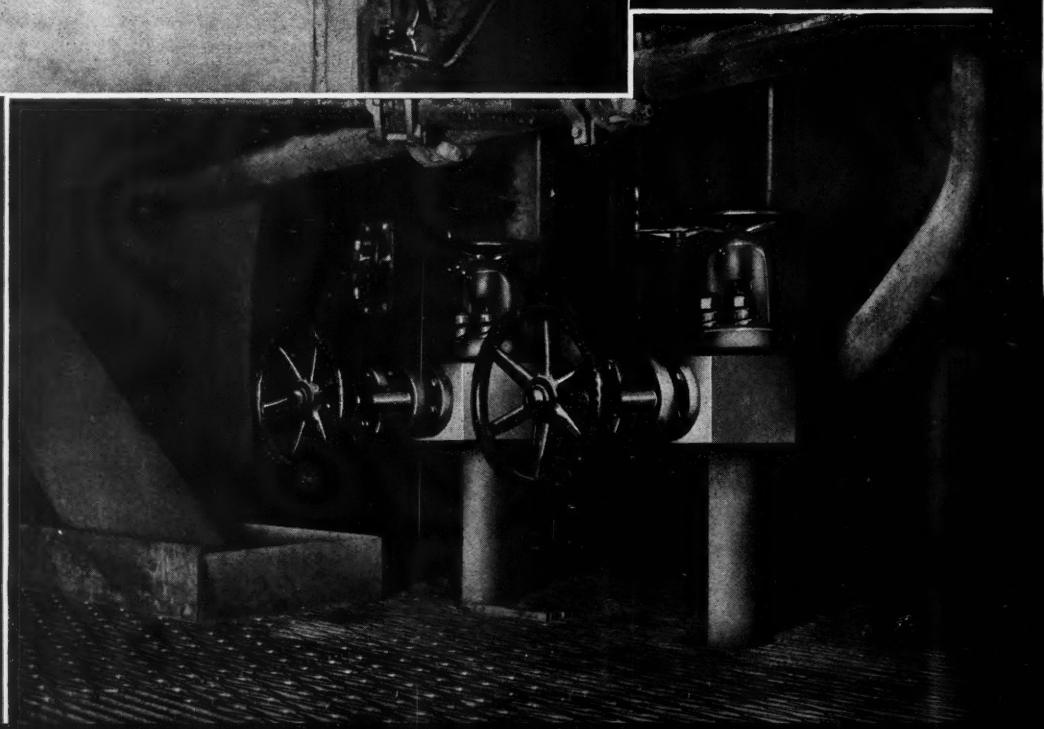
Sales Offices: Chicago—645 Marquette Bldg. ● Houston—229 Shell Bldg. ● Los Angeles—520 Anderson St. ● New York—(Eastern Division) 30 Church St. ● Tulsa—533 Mayo Bldg.

MIDWEST WELDING FITTINGS SAVE TIME, IMPROVE THE DESIGN, AND REDUCE THE COST OF PIPING SYSTEMS

YARWAY







Above: Yarway Unit Tandems on Water Wall Drains at West Reading Station of the Metropolitan Edison Co. There are 4 sets of these Tandems used—two sets on each of the two Boilers in the New Addition to this plant. These valves are used to drain the water-walls only when the installation is periodically shut down for maintenance.

Below: Two of the four sets of Yarway Unit Tandems on the two new Boilers at West Reading Station. These valves are used to blow down the lower drums about once per week.

YARWAY

B

Y at West Reading

Yarway Unit Tandem Blow-Off Valves Serve this 1400 lb, 900° Station Addition

ANOTHER in the long list of modern high pressure generating stations to select Yarway Unit Tandems for both water wall drains and boiler blowdown lines—the West Reading Station of the Metropolitan Edison Company. (Designing Engineers, Gilbert Engineering Co., Reading, Pa.)

Years of service in the highest pressure plants of leading utilities and industrials have proved the sound design and metallurgy of the Yarway Unit Tandem for blowing down or draining and sealing.

Such records as—"3000 blows at pressures of more than 1300 psi without a single replacement of parts or repairs of any nature"—have made this tandem the outstanding preference for high pressure blow off and draining service, today.

What are your draining and blowdown requirements? Write for Catalog. Section B-431 for pressures up to 2500 lb; section B-422 for lower pressures.

Yarway Unit Tandems are built for pressures up to 2500 lb. Combining a Hard-Seat and a Seatless valve in a single one-piece forged steel body, this Tandem provides the advantages of both designs—for blowing and for sealing—in a compact, rugged unit.

YARNALL-WARING COMPANY
114 Mermaid Avenue Philadelphia

BLOW-OFF VALVES

CONVERTING TO COAL?

HERE ARE A FEW CASE STUDIES WHICH MAY PROVE HELPFUL!

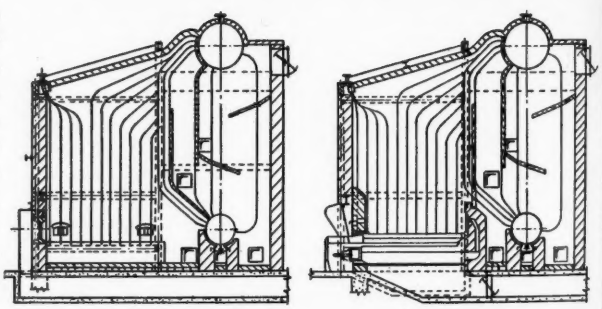
Conversion of oil-fired boilers to burn coal with minimum sacrifice of capacity and efficiency requires a competent analysis of the several factors affecting the selection of coal burning equipment.

A knowledge of these factors and how to evaluate them is essential to satisfactory results on any conversion project. As a means to a closer understanding of the varied conversion problems ordinarily encountered, a group of actual case studies are here illustrated and briefly discussed.

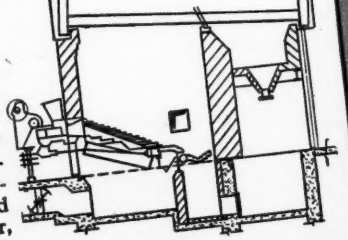
Combustion Engineering, having at its disposal the most complete line of fuel burning equipment available to any manufacturer, is singularly well equipped to work with your engineers or consultants to select the type of equipment best suited to your particular requirements.

For additional information write for pamphlet — "Factors Governing Conversion from Oil to Coal Firing"

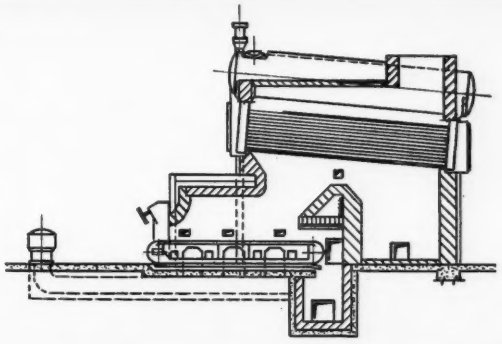
The left-hand illustration shows a 35,000 lb capacity oil fired steam generator as originally installed in a Connecticut industrial plant. The coal available was a good grade Eastern bituminous, suitable for either stoker or pulverized fuel conversion. The plant is located in a populous area and dust nuisance was to be avoided. After studying the situation, a type E, single-retort, underfeed stoker was selected. Only minor alterations to the setting and underfloor construction were required as shown by the right hand view.



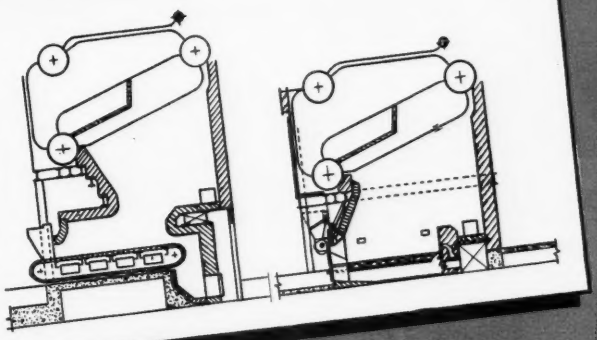
This sectional header boiler was originally installed in a Maryland plant to produce 62,000 lb of steam per hour when oil fired. The coal available to this plant was coking and caking bituminous suitable for underfeed, spreader or pulverized fuel conversion. The furnace had no water-cooled wall protection and was of limited volume. This virtually ruled out both pulverized fuel equipment and the spreader stoker as practical applications. The capacity required was too large for a single retort stoker, so a C-E Multiple Retort was selected. Its application is illustrated at right.



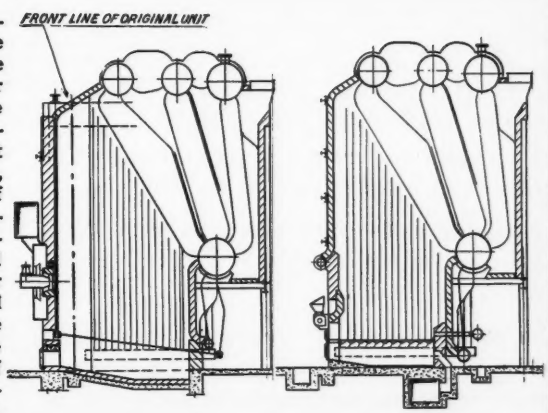
This 20,000 lb capacity box-header boiler was originally installed for oil firing in an area where anthracite was the coal most economically available. The logical equipment for coal firing, therefore, was a traveling grate stoker. Original furnace front wall, indicated by dotted lines, was removed and a dutch oven was added; likewise a rear arch and a bridgewall. Since there was no basement, underfloor construction was kept to a minimum by providing a moderately-sized ash pit extended at the side of the unit for removal of the refuse.



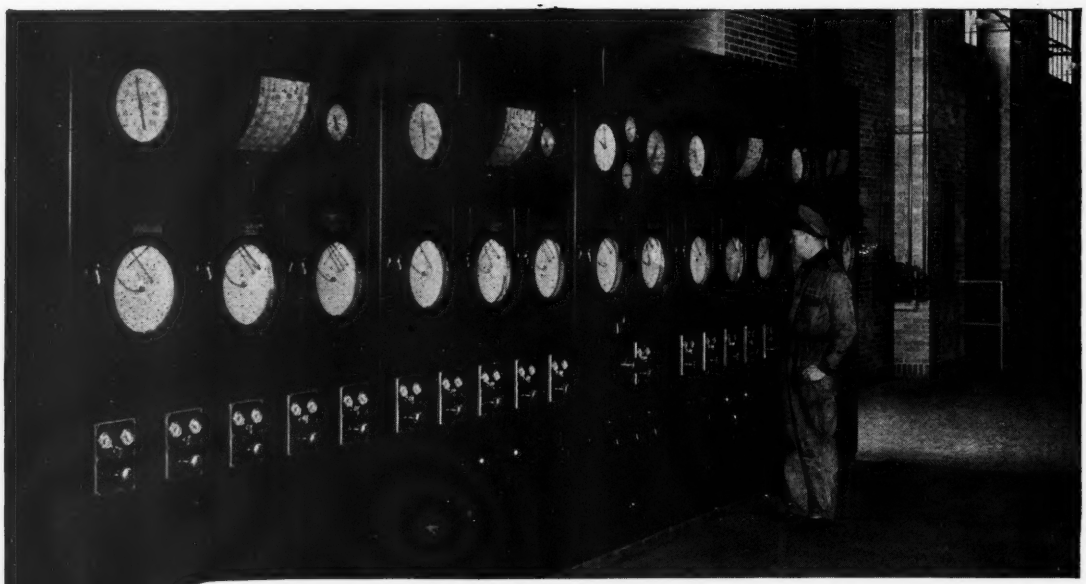
The drawings at the right illustrate an unusual conversion problem. Originally oil fired, this boiler is located in an area where anthracite is the low cost fuel. This would indicate the use of a traveling grate stoker. However, the boiler is set on a thick concrete mat only 2 feet below the normal operating floor. Obviously to raise the boiler, as shown at the left, to accommodate a traveling grate setting would be a difficult and costly operation. The relatively simple changes involved in making a good spreader stoker installation, as shown at the right, justify its selection even though it requires a more expensive coal.



The bent tube boiler shown here was designed to produce 75,000 lb steam per hour when oil fired. The setting was substantially as shown at the right. The available coal was suitable for either spreader stoker or pulverized coal firing. However, the furnace volume was inadequate for a satisfactory pulverized fuel conversion, and would have required moving out the front wall, adding a water screen above the furnace bottom, deepening the ash pit, as shown at the left, and of course, the purchase of the coal pulverizing and burning equipment. The spreader stoker required only revision of the lower front wall, building a stub bridgewall and providing a suitable air duct. Naturally the latter change was much less costly for both equipment and construction, and the studies revealed that the sacrifice in efficiency would scarcely justify the more expensive installation. In other cases, however, the advantages of higher efficiency and the flexibility of pulverized coal operation may well justify its selection over stoker firing.



COMBUSTION ENGINEERING
COMPANY, INC., 200 Madison Avenue, New York, N. Y.
A-704
C-E



BOILER CONTROL eases MANPOWER SHORTAGE

Continuity of Operation, Fuel Economy and Maximum Safety Can Be Maintained While Training New Operators

★ Power Engineers are now faced with the difficult task of operating at full capacity and high efficiency in spite of a serious lack of experienced manpower. Under these conditions complete boiler control is the power engineer's best friend and most trusted lieutenant. It stays on the job continuously and is a most valuable aid in carrying on normal operation while new manpower is being "broken in".

It maintains continuity of operation, fuel economy, and maximum safety equally well with experienced or inexperienced operators.

Bailey Boiler Control is a truly complete system. In addition to the usual functions of maintaining steam pressure, regulating furnace draft, and distributing load among boilers, it offers these additional values:

1. An automatic readjustment of the fuel—air ratio which functions continuously to insure economical combustion and safe furnace temperatures day after day.

2. No control system is better than its metering device—in the Bailey System control impulses are originated by standard Bailey Meters.

3. Provision is made for the protection of steam generating equipment by the addition of a purge interlock, fan failure interlocks and flame detectors.

A helpful discussion on the use of boiler control for war time power plant operation is contained in Bulletin No. 16, "How To Safely Stretch Steaming Capacity." A copy will be mailed to you upon request.

A-86-1

BAILEY METER COMPANY

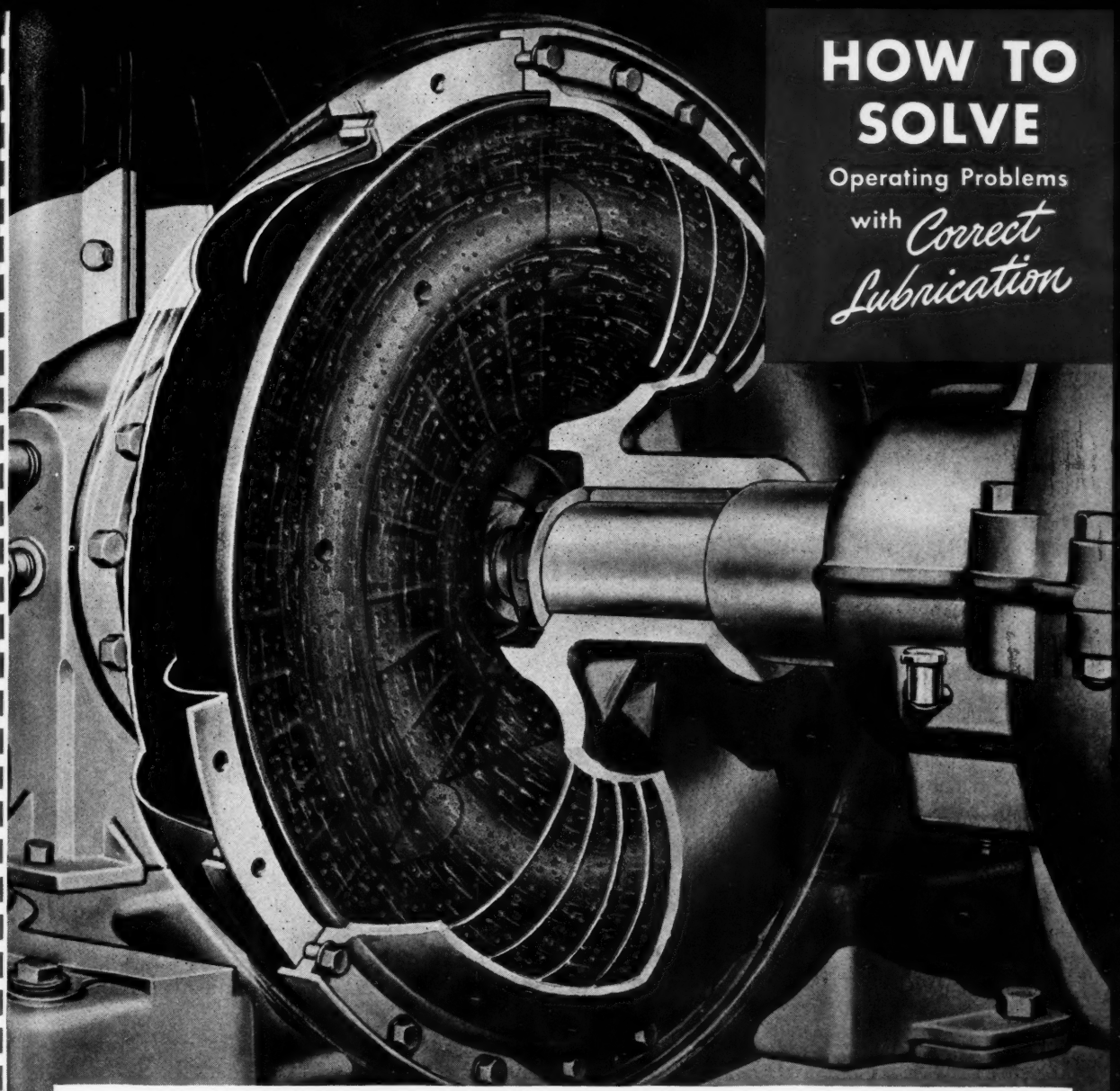
1040 IVANHOE ROAD • CLEVELAND, OHIO

Bailey Meter Company Limited, Montreal, Canada

BAILEY METER CONTROL

The Complete Combustion Control System

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEAT CONTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL



HOW TO SOLVE

Operating Problems with *Correct Lubrication*

Beware of Oxidation Here

PROBLEM: In this hydraulic coupling the power is transmitted by the oil in the shell. ***What happens to the oil?*** It is whipped and churned into a violent whirlpool. It gets hot. It mixes intimately with air. Unless the oil is specially made to resist oxidation under these conditions, it will form deposits which will interfere with the correct operation of the coupling.

ANSWER: You'll find Gargoyle Vacuoline Oils ideal for hydraulic systems. They've been designed to stand up under tough oxidizing conditions and give freedom from trouble-causing deposits. And they do it! Our man can give you plenty of proof of that. And, of course, the Gargoyle trade mark stamps it as an oil on which no corners have been cut. It's the finest oil our 77 years of experience can produce for this purpose!

GARGOYLE Lubricants

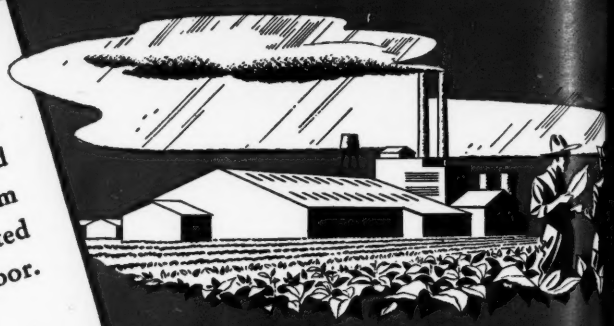
SOCONY-VACUUM OIL COMPANY, INC. — Standard Oil of N. Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. White Eagle Div. • Wadhams Div. • Magnolia Petroleum Company • General Petroleum Corporation of California

CALL IN SOCONY-VACUUM

WHEN PERFORMANCE COUNT

YOU CAN COUNT ON A-E-CO TAYLOR STOKERS

A CASE IN THE TOBACCO INDUSTRY



PROBLEM:

The situation at this plant was unusual. Firing equipment had to be selected which, burning the widest range of coals economically available, would operate at maximum efficiency with a minimum furnace volume. The existing plant was of limited height and had no basement below the firing floor.

SOLUTION:

Upon due consideration of the requirements, a Taylor Continuous Ash Discharge Stoker was installed under a 70,000 lb. per hour steam generator. No heat recovery equipment was purchased.

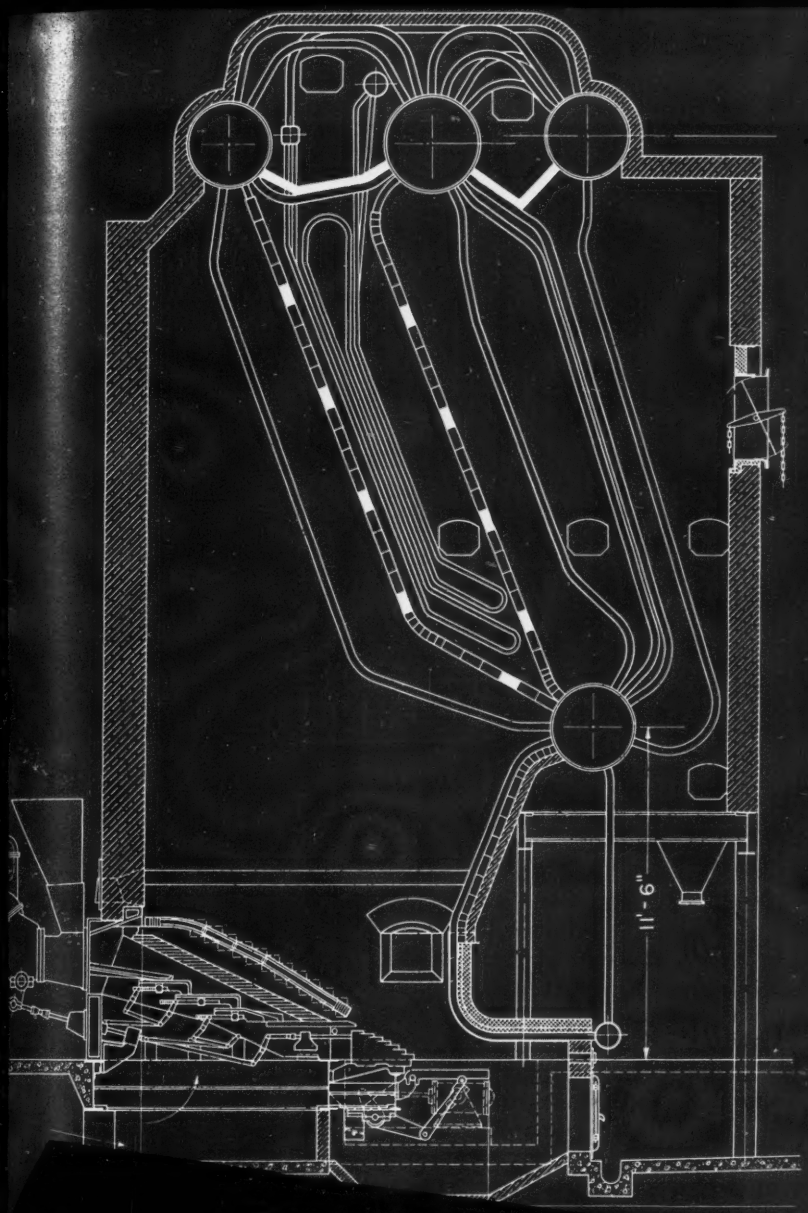
RESULTS:

The unit was placed in service March 24, 1940. A recent report on performance from that date until April 30, 1942 disclosed 442,884,000 lbs. of steam generated from 45,311,280 lbs. coal (average evaporation; 9.77 lbs. steam per lb. of coal). The coal contained an average content of 13,890 B.T.U. per lb. as fired. Operating conditions; 410 lbs. pressure, gauge; 650°F. total steam temperature; 277°F. feed temperature to boiler. The combined efficiency of the unit was 79.9%. It is interesting to note that the unit was in service 17,448 of the elapsed time of 18,432 hours, or available 94.6% of the time.

CONCLUSIONS:

This case demonstrates t
important advantages
the Taylor Stoker—its abi
to burn a wide range
coals economically and
ease with which it can a
form to limitations of spa
By eliminating the need
new construction, the spa
advantage of the Tay
Stoker contributes to cons
vation of essential materi

AMERICAN ENGINEERI C
PHILADELPHIA · PENNSYLVA



A-E-CO TAYLOR STOKERS ON THE FIRING LINE

*Aluminum Company of America #1
*Aluminum Company of America #2
American Tobacco Co., Inc., Durham, N. C.
Cannons Paper Company
Chrysler Corporation, Dodge Plant
*Collins and Aikman Corp., Roxboro, N. C.
City of Columbus, Ohio
*Consolidated Paper Company
*Cresson State Sanitarium, Cresson, Penna.
Defiance Milk Products Co., Defiance, Ohio
*DeLaval Steam Turbine Co.
*Detroit Sulphite Pulp & Paper Co.
City of Dover, Ohio
*Draper Corporation
Erwin Cotton Mills Co.
*Fisher Body Corporation #1
Fisher Body Corporation #2
*Fisher Body Corporation #3
*Fisher Body Corporation #4
Fox Paper Company
Froedtert Grain and Malting Co., Milwaukee, Wisc.
*City of Galion, Ohio
*Gardner-Richardson Company
*General Electric Company #1
*General Electric Company #2
*Greenwood Electric L. & W. Plant
*Board Public Works, Hannibal, Mo.
Hill School, Pottstown, Penna.
*Hobart Mfg. Co.
*City of Holland, Michigan
*Hope Natural Gas Co.
Hudepohl Brewing Co., Cincinnati, Ohio
Industrial Cotton Mills
*City Water & Light Plant, Jonesboro, Ark.
Kohler Company
Maryland State Penal Farm, Roxbury, Md.
*Marbury Sanitarium, Northville, Michigan
Michigan Carton Company, Battle Creek, Michigan
*Michigan State College, East Lansing, Mich.
Municipal Light Plant, Marshfield, Wisc.
*Pacific Mills
*Packard Motor Car Co.
*Municipal Electric Plant, Pelonsville, Ohio
*Park Deep Forge
*Pennsylvania Electric Co.
*Pennsylvania R. R. Co., Philadelphia, Penna.
*Pittsburgh Plate Glass Co.
Borough of Quakertown, Quakertown, Penna.
Raleigh Wyoming Mining Co., Glen Rogers, W. Va.
Schmeltzer Paper Company
City of Richland Center, Wisconsin
*City of Richmond, Indiana
Sayles Bilmore Bleachery, Bilmore, N. C.
Scoeten Dillon Company
Shelby Cotton Mills
Sloane-Blabon Corp.
*Solvay Process Company
*St. Elizabeth's Hospital, Washington, D. C.
City of St. Bernard, Ohio
Swarthmore College, Swarthmore, Penna.
*Timken Roller Bearing Co. #1
Timken Roller Bearing Co. #2
Municipal Water & Light Plant, Tippecanoe City, O.
City of Toledo, Ohio
*Union Bleachery, Greenville, S. C.
Union Mills Paper Mfg. Co.
*University of Wisconsin, Madison, Wisc.
*Vassar College, Poughkeepsie, New York
*Borough of Vineland, New Jersey
Warfield Natural Gas Company, Harold, Kentucky
White Sewing Machine Co.
Whiting Plover Paper Company

(*) *Represents repeat orders.*

A-E-CO TAYLOR STOKER

A-E-CO TAYLOR STOKERS
WATER WALLS · ASH HOPPERS
HELE-SHAW FLUID POWER
MARINE DECK AUXILIARIES
LO-HED HOISTS

COMPANY

ARE YOU JUDGING YOUR STOKER BY THESE TWELVE POINTS?

1. **RELIABILITY**—the ability to operate with minimum outage and minimum standby equipment.
2. **CAPACITY**—the ability to provide adequate prime capacity ratings, with sufficient reserve capacity for emergencies.
3. **MAINTENANCE**—the ability to operate continuously with minimum repair costs.
4. **FLEXIBILITY**—the ability to follow the steam demand upward or downward . . . quickly and without sacrificing efficiency.
5. **EFFICIENCY**—the proved dollar efficiency (total cost of steam production) as shown by actual performance in similar installations.
6. **OPERATION**—the ability to operate continuously, the number and type of operations required, the ease of combustion adjustments, etc.
7. **ADAPTABILITY**—the ability to meet special and limiting conditions, present and future—structural limitations, utilization of present equipment, growth and change of power service demands.
8. **FUEL FLEXIBILITY**—the ability to burn efficiently and easily fuels from many sources having widely varying characteristics.
9. **REFUSE DISPOSAL**—the ability to economically eliminate ash or refuse and the opportunities of disposal at low cost, no cost, or profit.
10. **STACK DISCHARGE**—the practical elimination of "smoke nuisance" without special equipment.
11. **SPACE REQUIREMENTS**—the ability to conform to existing or future space limitations, to short and wide or long and narrow furnaces. Also the accessibility of component parts for maintenance and operation.
12. **OBSOLESCENCE**— the adaptability of the equipment toward possible future modernization with minimum of complication and outage.

14 years of continuous service

In spite of greatly increased war demands, the boilers in the power plant of a Pittsburgh steel company have operated for 14 years with no unscheduled outages. This company has been a client of Hall Service during the entire period.

One boiler "pinch hits" for six

An army tank manufacturer needed considerable new steam capacity. It was planned to replace 6 old boilers with 3 new ones. During the changeover one new boiler was forced to operate continuously at 400% rating to handle the load. The water treatment established by Hall Laboratories functioned perfectly. Not one tube burned out . . . not one minute's production time was lost.

No forced shutdowns in 6 years

A large company making paper board has been operating under Hall Service for six years. In that time no forced shutdowns have occurred because of scale, corrosion, embrittlement, carryover or other boiler ills due to water.

Somebody ought to strike a medal for them

WAR PRODUCTION HAS PRODUCED SOME VALIANT RECORDS FROM PEACE-TIME BOILER VETERANS

IN a thousand industrial power plants sturdy "old timers" in the boiler army have been meeting the severest strain in their years of service and carrying on with a minimum of casualties.

It wasn't like that in World War I when boiler shutdowns for repairs were a daily crisis in war industries and there wasn't any help for it.

That costly experience gave birth to a chain of developments which altered the whole course of boiler practices in the industrial world.

First, Hall chemists, after years of penetrating research, found the right answer to scientific boiler water conditioning. Next, Hall Laboratories instituted the system for preventive care which has made it known throughout the world. Then Hall field engineers put this service into operation in the leading power plants throughout the nation.

That's why boiler casualties in World War II are the lowest in history. Preventive care is a "must" in every important power plant today. It is the only insurance against boiler ills which have their origin in water conditions. No plant is so fully equipped to meet its own problems that it can afford to be without the specialized assistance Hall offers.

For your own plant security it will pay you to investigate what Hall preventive care has to offer.

HALL LABORATORIES, INC. · HAGAN BUILDING · PITTSBURGH, PA.

A Subsidiary of Hagan Corporation

HAGAN
HALL
BUROMIN
CALGON

HALL SYSTEM
of Boiler Water Conditioning

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

They sold their stock of spare tubes

Before Hall Service was started in a certain power plant, the maintenance department had to keep a big stock of spare tubes on hand at all times. After Hall Service began, no more tubes burned out over a stretch of years, so they decided to sell most of their now unnecessary surplus.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Here's DEPENDABLE POWER

. . . the kind of power that will always win your war of production

War-time production needs and fuel shortages have served only to emphasize the necessity for a dependable source of power in the boiler room. Contracts for tools of war have gone to those who can PRODUCE WITHOUT INTERRUPTION . . . the same procedure will prevail when the time comes to turn out the products of peace.

"F&E" Underfeed Stokers have proved their ability to provide this dependable power. "F&E" engineers recognized this need years ago . . . and today thousands of "F&E" installations—in practically every type of boiler room—using practically every grade of coal—give evidence that "F&E" Stokers fulfill the most exacting requirements. Efficiency, economy and low maintenance rule.

Specify "F&E" Underfeed Stokers and get EXTRA dividends from your boiler room.

FLYNN & EMRICH CO.

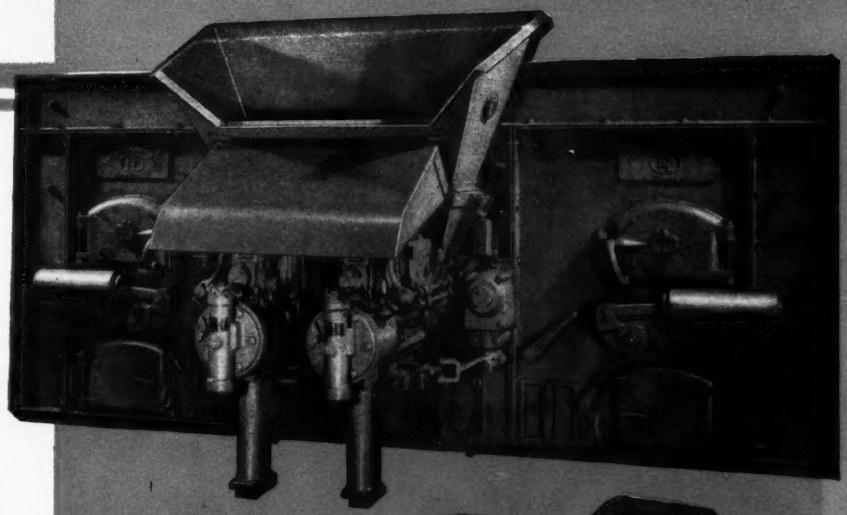
Established 1842

HOLLIDAY & SARATOGA STS., BALTIMORE, MD.

Representatives in Principal Cities

ONLY "F&E" GIVES YOU THIS COMBINATION OF FEATURES THAT ASSURE PERFECT COMBUSTION

1. Electro-Hydraulic Drive — Foolproof and dependable—only 5 moving parts.
2. "F&E" Interval Timer Governor (patented)—Provides perfect control of fuel feeding rates.
3. Retort Sliding Bottom — Assures even fuel distribution.
4. Exterior Fuel Bed Regulator—Permits Adjustment of Burning Fuel Bed.
5. Removable Ram Case Liner—Reduces Maintenance — Eliminates Shutdowns During Replacement.
6. High Efficiency Tuyeres—Scientifically Designed; made of Special Heat-Resisting Metal.



A FEW COMPANIES WHO DEPEND ON "F&E" STOKERS FOR POWER

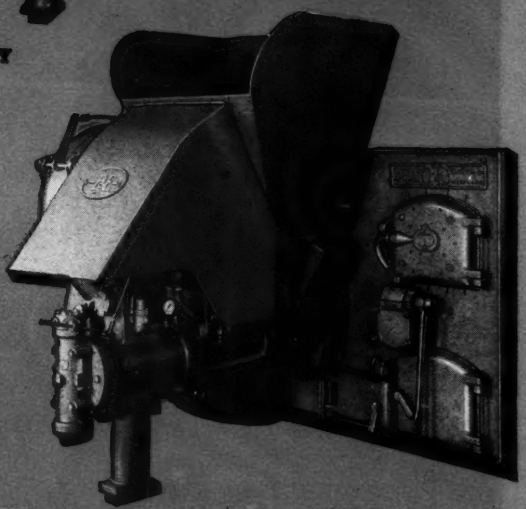
Public Service Co. of N. J.
*Revere Copper and Brass Co.
*Stauffer Chemical Co.
*Ohio Crankshaft Co.
High Standard Mfg. Co.
*Hydraulic Press Mfg. Co.
Cleveland Crane & Engineering Co.
*University of Alabama
*Eastern Rolling Mill Co.
*Brockway Glass Co.
R. J. Peacock Canning Co.
*Greenfield Tap & Die Co.
*Hoffman-La Roche Inc.
Vick Chemical Co.
*Flintkote Co.
National Grain Yeast Co.
Consolidated Laundries Corp.
*John Wanamaker
*American Stores
*S. Austin Picking Paper Co.
*American Cyanamid Co.
*Pratt & Whitney Aircraft Corp.
*Edgewood Arsenal
*Aberdeen Proving Grounds
*R. C. A. Manufacturing Co.
*The Ruberoid Co.

Indicates repeat orders.

THE "F&E" HEAVY DUTY SERIES 70
For boilers generating from 10,000 to 40,000 lbs. of steam per hour.

THE "F&E" SERIES 60
For boilers generating from 4,000 to 12,000 lbs. of steam per hour. Anthracite and bituminous types.

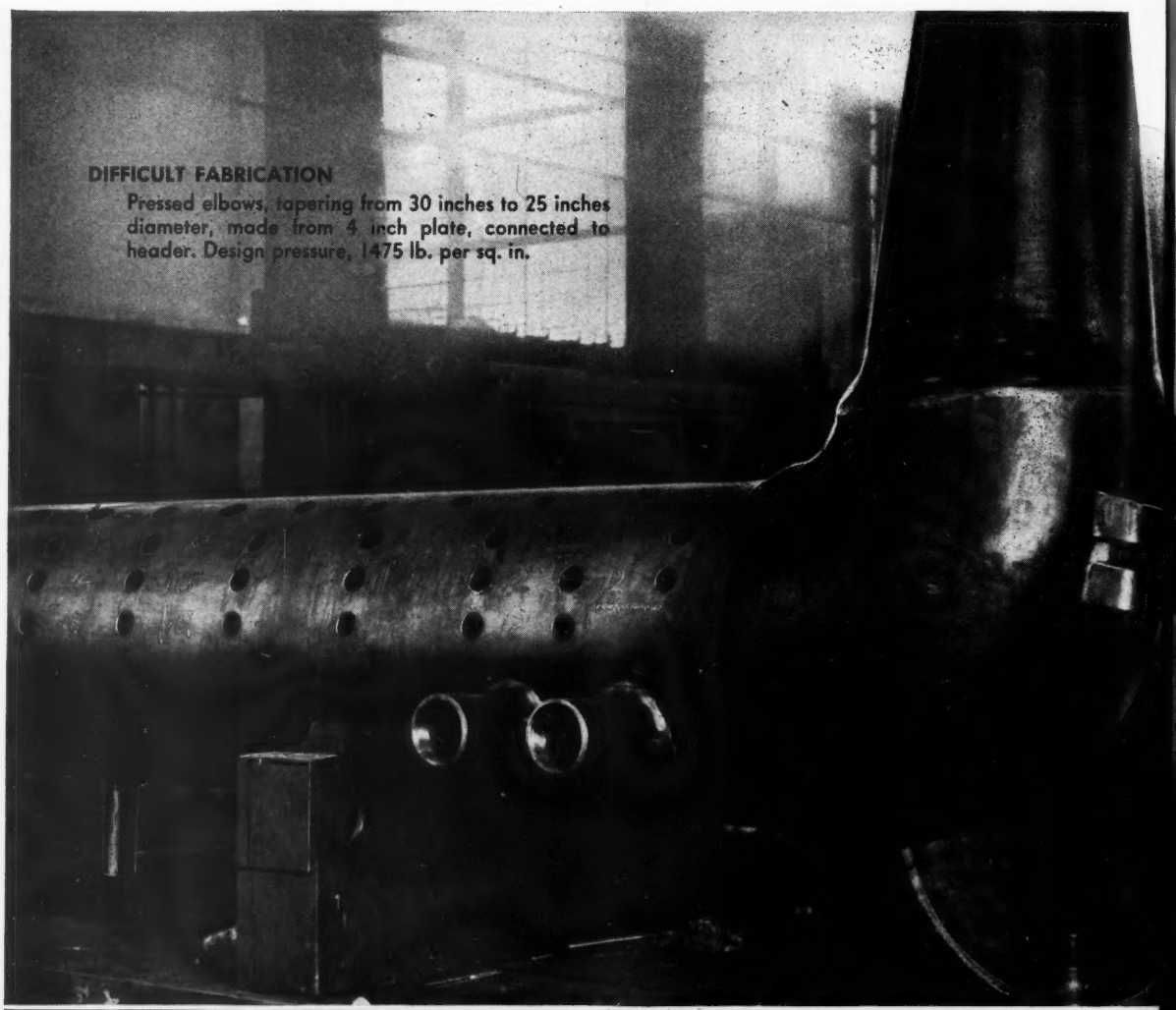
THE "F&E" SERIES 40
For boilers generating from 750 to 3,000 lbs. of steam per hour. Anthracite and bituminous types.



Every stoker installation is an individual problem. That is why "F&E" stokers have been designed for versatility. Three basic models shown above serve as backgrounds. Series 70 is furnished with single or double retort, electro-hydraulic or steam drive, stationary or moving grates . . . according to the requirements of your particular firing job.

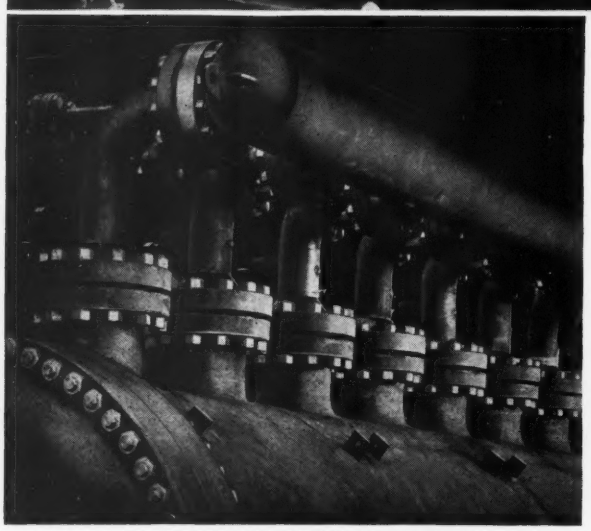
F&E

UNDERFEED STOKERS



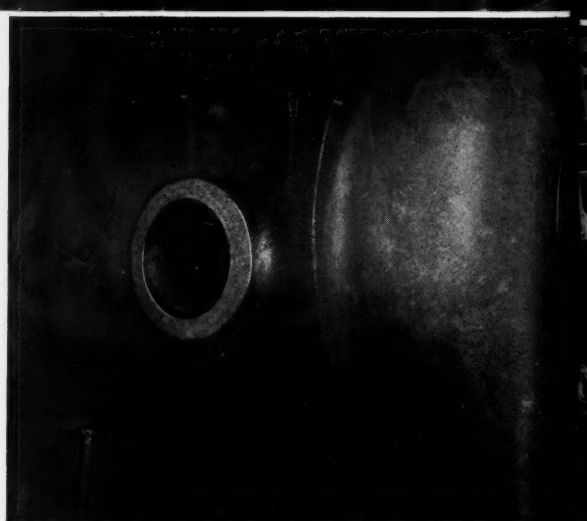
DIFFICULT FABRICATION

Pressed elbows, tapering from 30 inches to 25 inches diameter, made from 4 inch plate, connected to header. Design pressure, 1475 lb. per sq. in.



VESSELS FOR HIGH TEMPERATURE SERVICE

Vessel shown is built of Croloy 2 plate, with streamlined openings — for service at 100 lb. per sq. in. and 1050 F.



VESSELS FOR HIGH PRESSURE SERVICE

Showing pushout connection welded in 66 inch diameter shell. Design working pressure, 1475 lb. per sq. in. Pushout made of 6¼ inch plate.

B&W process equipment solves problems of temperature and pressure

B&W designing skill and manufacturing experience are developing new and practical solutions for problems encountered in installations of vessels, drums, castings, forgings and tubular products where high temperatures or high pressures must be withstood. Production of such equipment represents a major activity at B&W, where an outline of *your* problem will be welcomed.

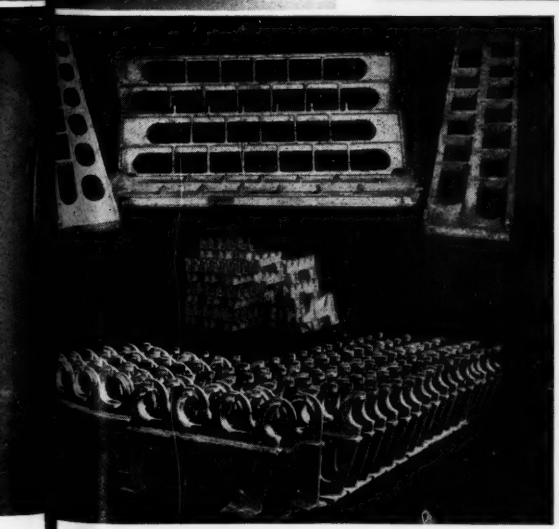
S-32-T

BABCOCK & WILCOX

VESSELS. DRUMS. CASTINGS. FORGINGS

FOR HIGH-TEMPERATURE, FOR HIGH-PRESSURE SERVICE.

THE BABCOCK & WILCOX CO., 85 LIBERTY ST., NEW YORK, N. Y.



ALLOY TUBE SUPPORTS

More than two million pounds of B&W Alloy Tube Support Castings have been supplied for service temperatures as high as 2000 F., where high creep strength is required. Not a service failure has been reported.

B&W STREAMLINED OPENINGS

All reinforcing is forged and drawn from parent metal. Concentration of stresses is avoided.

FLASH and
OIL IS AMMUNITION
USE IT WISELY !
DRUMS! DRUMS! DRUMS!
War needs make it extremely important that all empty drums be returned immediately.
INDUSTRIAL
TYCOL
OILS-GREASES
SCIENTIFICALLY ENGINEERED
FOR EVERY INDUSTRIAL USE
TYCOL

FIRE

This is #2 of a series of informative messages concerning the meaning and significance of commonly used tests and terms employed to describe the characteristics of lubricating oils.

TIDEWATER LUBRICANIA

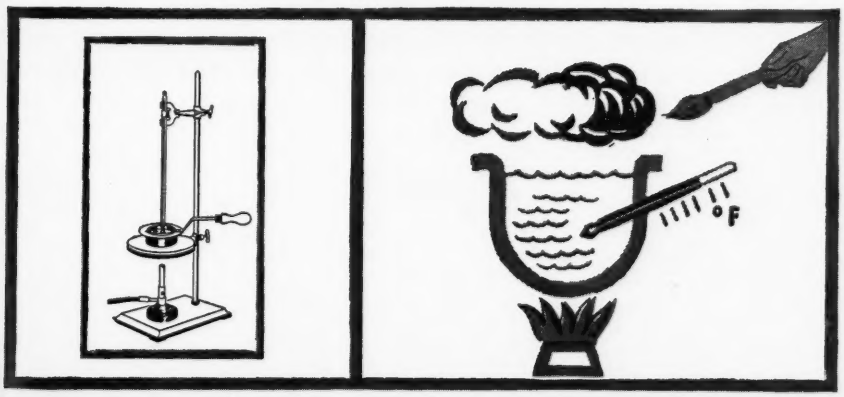
DEFINITION: That temperature at which a lubricating oil will first give off sufficient vapors to ignite when approached by a small flame or spark is termed the flash point—the lowest temperature at which when ignited, the oil continues to burn is called the fire point.

TEST: The flash point and the fire point of lubricating oil are usually determined by means of the Cleveland Open Cut Tester by following a definitely prescribed procedure. The oil under test is heated and a small pilot flame is moved over the cup with every 5°F rise in oil temperature. The first time a flash occurs on the surface of the oil, the temperature of the oil is recorded as the flash point. If the oil is heated still further and tested with the pilot flame, it will commence to burn with a continuous flame. When this occurs the oil temperature is recorded as the fire point.

For most purposes knowledge of the Flash Point alone is sufficient. It indicates the ordinary fire hazard in handling petroleum fuels and similar volatile products. With lubricating oils, Flash Points sufficiently high to avoid undue evaporation losses in service are definitely required.

The following illustrates examples of flash points of typical petroleum products, fire points being somewhat higher:

Gasoline .....below 0°F	Kerosene .....115-150°F
Cleaning Naptha ....110-115°F	Light Machine Oil....325-400°F
Heavy Cylinder Oil..525-625°F	



Tycol lubricants are subject to rigid flash point control during manufacture. Uniformly correct flash points, insuring undiluted products in every grade, are one of many Tycol characteristics contributing to high quality.

TIDE WATER ASSOCIATED OIL COMPANY

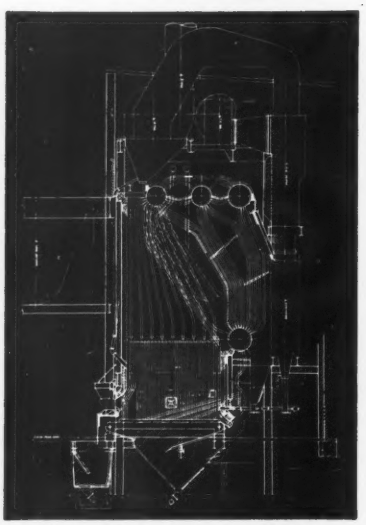
Eastern Division: 17 Battery Place, New York • *Principal Branch Offices:* Boston, Philadelphia, Pittsburgh, Charlotte, N. C.

MAKERS OF THE FAMOUS VEEDOL MOTOR OIL

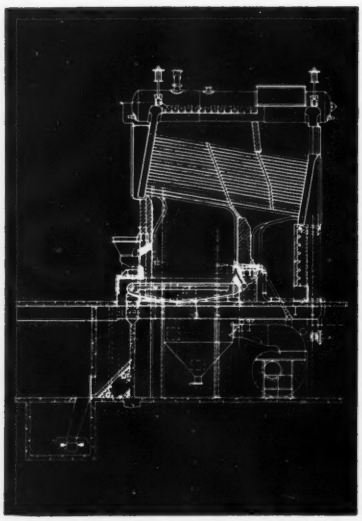
INDUSTRIAL LUBRICANTS

DETROIT ROTOGRATE STOKER

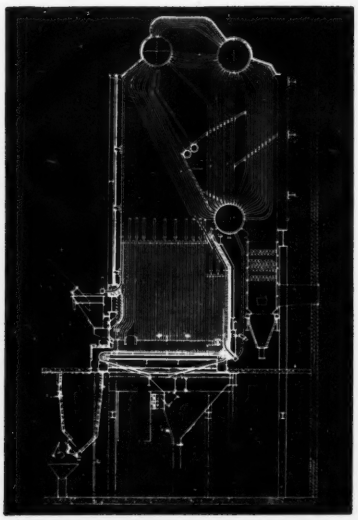
PROVEN SUCCESSFUL WITH MEDIUM AND LARGE UNITS



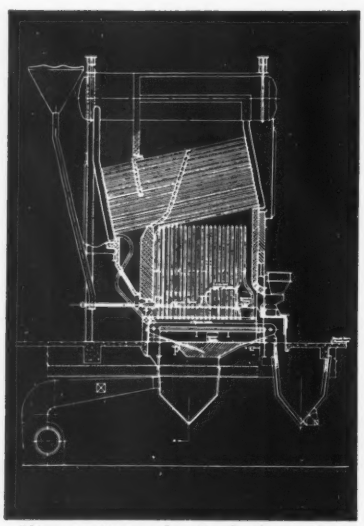
Illinois Coal—Capacity 75,000 pounds steam per hour.



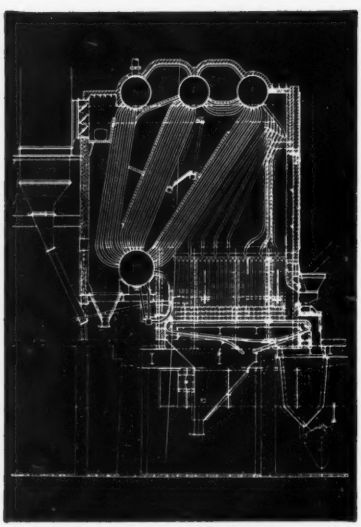
Kansas Coal—Capacity 30,000 pounds steam per hour.



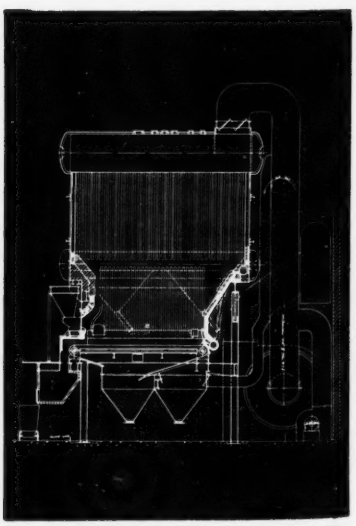
Indiana or Illinois Coal—Capacity 225,000 pounds steam per hour.



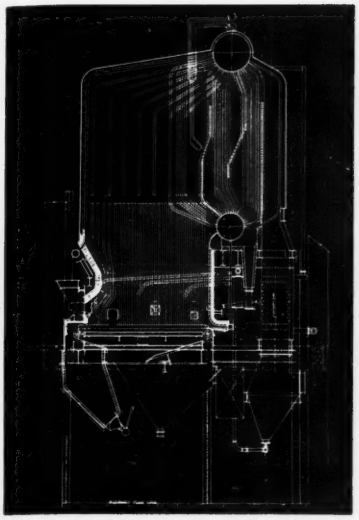
Western Kentucky Coal—Capacity 80,000 pounds steam per hour.



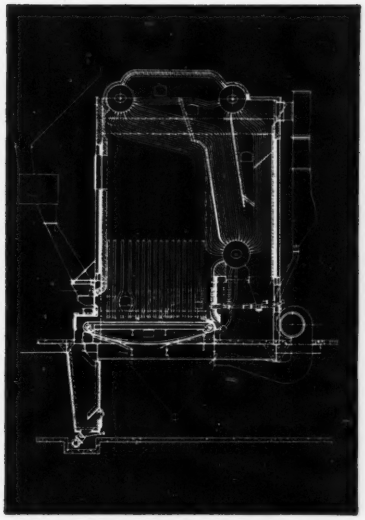
Iowa Coal—Capacity 50,000 pounds steam per hour.



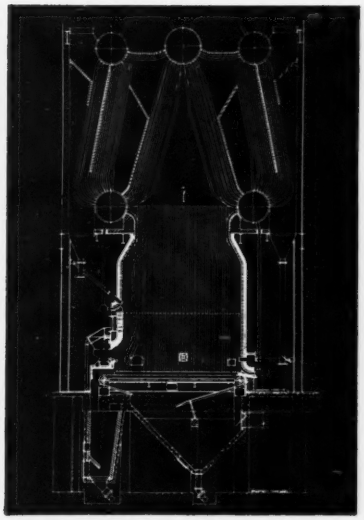
West Virginia Coal—Capacity 70,000 pounds steam per hour.



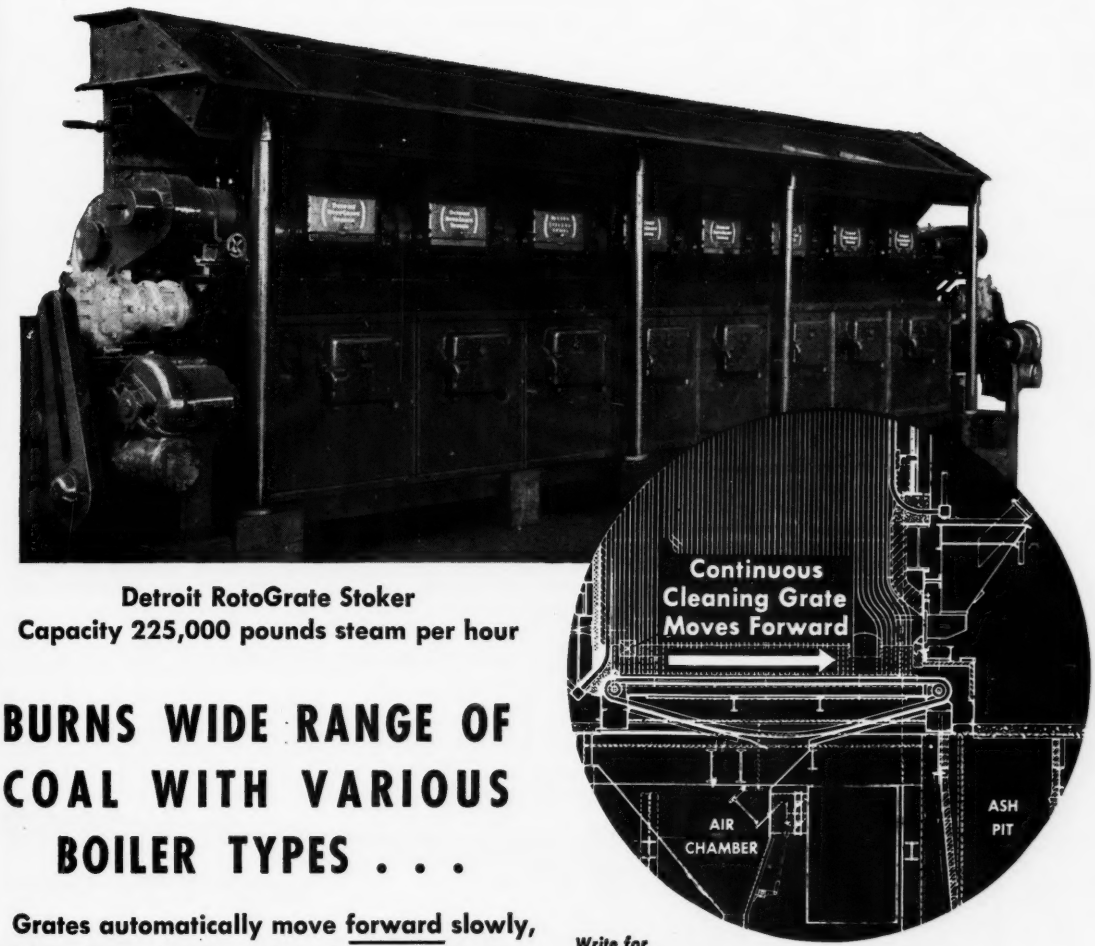
Tennessee or Eastern Kentucky Coal—
190,000 pounds steam per hour.



Eastern Kentucky Coal—Capacity
75,000 pounds steam per hour.



Illinois Coal—Capacity 225,000
pounds steam per hour.



Detroit RotoGrate Stoker
Capacity 225,000 pounds steam per hour

BURNS WIDE RANGE OF COAL WITH VARIOUS BOILER TYPES . . .

Grates automatically move forward slowly, continually discharging the ash at the front end of the furnace. Fine particles of fuel are burned in suspension and the coarse coal on the moving grate, with no special coal preparation.

Write for Bulletin

DETROIT STOKER COMPANY

General Motors Building
Detroit, Michigan

Automatic AIR ELIMINATION is

ADVERSE EFFECT OF AIR ON STEAM TEMPERATURE

Fig. 1 represents a pressure chamber filled with air at 14.7 lb. absolute pressure. Each diamond represents a molecule of air.

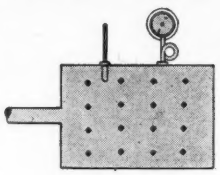


Figure 1

In Fig. 2 the same pressure vessel is filled with steam molecules, represented by crosses, at 14.7 lb. absolute pressure. Since the pressure is the same there are the same number of molecules as in Fig. 1. Steam temperature is 212 deg. F.

Fig. 3 represents the pressure chamber filled with the same amount of air as in Fig. 1 plus the same amount of steam as in Fig. 2. Since there are twice as many molecules in the same space, the pressure is doubled or 29.4 lb. absolute. However, in spite of the increased pressure, there are no more steam molecules than in Fig. 2 and the pressure due to steam is still 14.7 lb. absolute so the temperature is 212 deg. F.—*no increase in temperature despite increase in pressure.*

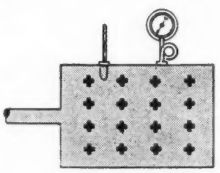


Figure 2

The same problem from another approach: Assume every steam molecule in Fig. 3 except one is replaced by an air molecule. The pressure will remain at 29.4 lb. absolute but with a single steam molecule in a pressure chamber of any size, the temperature would be approximately room temperature rather than 212 deg. F. — *air lowers temperature.*

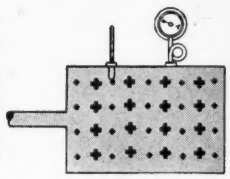


Figure 3

ADVERSE EFFECT OF AIR ON HEAT TRANSFER

Rate of heat transfer will be reduced far more than the reduction in steam temperature might indicate unless the velocity of entering steam is sufficient to keep the air and steam mixed perfectly. A mixture of steam and air will flow to the surface to replace steam that is condensed but the steam will be to some extent prevented from reaching the surface by air that remains after the steam is condensed. This is shown in Fig. 4.

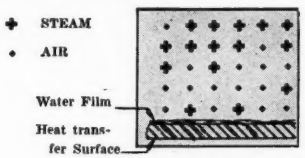


Figure 4

In time the concentration of air on the heating surface may be many times as great as the concentration of air mixed with steam at some distance from the surface. It has been stated by one authority that under extreme conditions, one-half of 1% by volume of air mixed with steam may result in a reduction of heat transfer efficiency as great as 50%.

Table showing temperature reduction caused by air at various pressures.

Gauge Pressure	Temperature of Steam with No Air Present	Temperature of Steam Mixed with Various Amounts of Air. (Per Cent Air by Volume)		
		10%	20%	30%
10.3	240.1	234.3	228.0	220.9
25.3	267.3	261.0	254.1	246.4
50.3	298.0	291.0	283.5	275.1
75.3	320.3	312.9	304.8	295.9
100.3	338.1	330.3	321.8	312.4

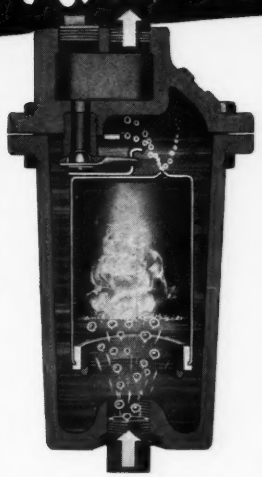
ARMSTRONG "INVERTED BUCKET" STEAM TRAP

Armstrong

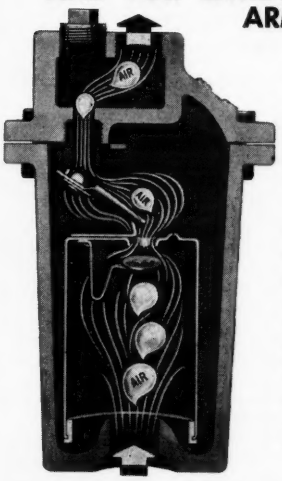
N is an essential of GOOD TRAPPING

HOW ARMSTRONG TRAPS ELIMINATE AIR

The illustration at the right shows how air, always present in steam, is eliminated through the vent in the Armstrong Inverted Bucket. Any air entering the trap ahead of condensate or coming in with the steam, passes through this vent. It collects at the top of the trap and is discharged ahead of the condensate when the valve opens. (Any steam escaping through the bucket vent is condensed by the surrounding water to help make up for the radiation loss from the trap.)



AND FOR EXTRA FAST AIR REMOVAL — ARMSTRONG BLAST TRAPS



Where large amounts of air must be handled quickly when the steam is first turned as is often desirable with low pressure heating or "up-and-down" process units, the Armstrong Blast Trap illustrated at the left will work wonders in speeding up heating.

An Armstrong Blast Trap differs from a standard trap only in that the inverted bucket is equipped with an auxiliary air vent which is controlled by a flat disc mounted at the end of a strip of rustless thermostatic bi-metal. When steam is first turned on, the auxiliary vent in the top of the bucket is wide open which prevents the bucket from floating and closing the discharge valve. Air and water blow straight through (see picture at left) until steam comes in and causes the bi-metal strip to bend upward, closing the auxiliary vent. Thereafter, the trap works the same as a standard trap.

USERS of Armstrong Steam Traps know that they will meet all the conditions imposed upon them by almost any operating conditions. Armstrong Traps eliminate air and discharge condensate as fast as it forms under light, heavy or intermittent loads with no steam leakage. They handle all ordinary dirt and scale. The valve is immune to wire-drawing. There are no parts to stick, bind or wear rapidly. They are simple, long-lived and easy to inspect and maintain. Choice of body styles makes installation simple.

These features will help you save time, fuel and manpower, help you increase plant output. Find out more about Armstrong Traps today.

ARMSTRONG MACHINE WORKS

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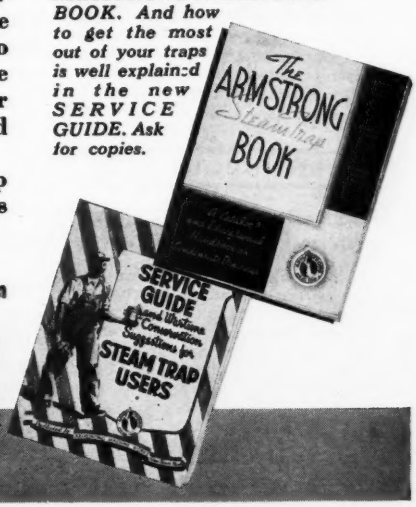
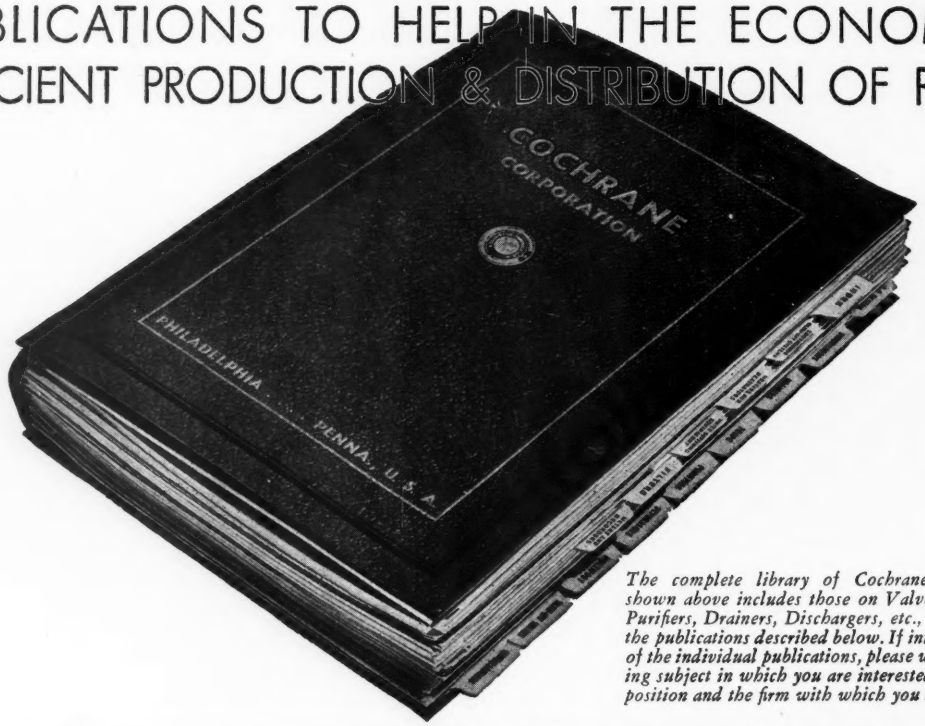
• How to select the right trap for the job is easy with The ARMSTRONG STEAM TRAP BOOK. And how to get the most out of your traps is well explained in the new SERVICE GUIDE. Ask for copies.



STEAM TRAPS

PUBLICATIONS TO HELP IN THE ECONOMICAL EFFICIENT PRODUCTION & DISTRIBUTION OF POWER



The complete library of Cochrane publications shown above includes those on Valves, Separators, Purifiers, Drainers, Dischargers, etc., in addition to the publications described below. If interested in any of the individual publications, please write, mentioning subject in which you are interested, giving your position and the firm with which you are connected.

WATER SOFTENING

Publication 3000: Cochrane HOT PROCESS SOFTENERS

A treatise on the subject of the treatment of boiler feedwater, with particular reference to the different methods of softening, and specifically that of hot process softening. Details of design and apparatus, with hook-ups and descriptions of heaters, proportioners, etc., are included. A special section on the chemistry of feedwater treatment with formulae and molecular and equivalent weights is a valuable part of this publication. 48 pages, 3 colors, 8½" x 11".

Publication 2860: Cochrane ZEOLITE WATER SOFTENERS

A complete discussion of the subject of cold softening of water for industrial uses, such as boiler feed, laundries, textiles, the canning industry, institutions, hospitals, etc., with a description of the Zeolite method of softening, details of the apparatus required, how to compute capacity needed, with diagrams of types of units and photographs of typical installations. Complete tables of weights, capacities and dimensions are included. 20 pages, 2 colors, 8½" x 11".

CONTINUOUS BLOW-OFF SYSTEMS

Publication 2770: Cochrane CONTINUOUS BLOW-OFF SYSTEMS

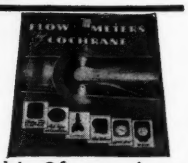
An interesting and informative discussion of the advantages of continuous boiler blow-down as compared with intermittent blow-down. Savings are such that cost of equipment can be returned in a year's time, in most cases. The great saving is in heat recovery and the big advantage is in the uniformity of boiler water concentration avoiding priming and foaming or carry-over. 12 pages, 2 colors, 8½" x 11".

DEAERATION, HEATING, HOT WATER STORAGE

Publication 3005: Cochrane DEAERATORS

A completely illustrated booklet on the subject of conditioning feedwater to prevent corrosion of piping, boiler tubes, economizers, etc., with especial reference to heating, deaeration and degasifying. Different types of deaerators and deaerating heaters are illustrated and described together with a discussion of the advantages of the parallel down-flow principle. Fully illustrated with diagrams and photographs. 36 pages, 3 colors, 8½" x 11".

FLOW METERS



Publication 3010: FLOW METERS by Cochrane

This large fully illustrated publication covers in detail the measurement of fluid flow, liquid level, temperature, pressure, etc. There is much basic material on instrumentation as well as specific data on particular types and models. Of great value to all operators and executives. 56 pages, 3 colors, 8½" x 11".

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In addition, these units produce a permanent, low-maintenance system while using critical materials amounting to only 15% to 20% of their total weight . . . And they require for shipment only 20% to 25% of the space in available gondola cars that would be required for an equal footage of other types of conduit construction. • Speed is the essence of wartime construction—and Ric-wiL Prefabricated Pipe Units have proved a definite aid.

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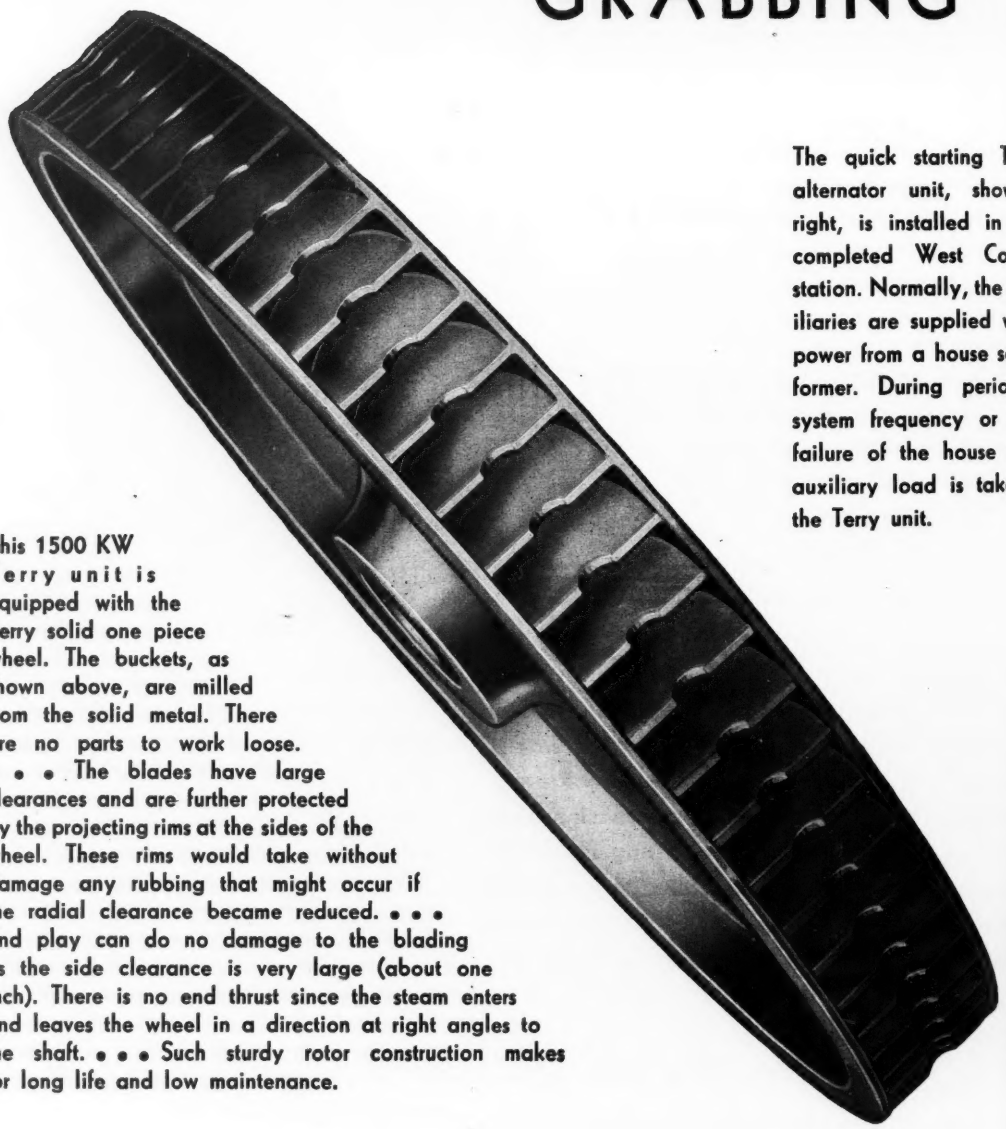
RIC-WIL CONDUIT SYSTEMS FOR UNDERGROUND STEAM
THE RIC-WIL COMPANY · CLEVELAND, OHIO
AGENTS IN PRINCIPAL CITIES

The TERRY

GRABBING A5



This 1500 KW Terry unit is equipped with the Terry solid one piece wheel. The buckets, as shown above, are milled from the solid metal. There are no parts to work loose. • • • The blades have large clearances and are further protected by the projecting rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the radial clearance became reduced. • • • End play can do no damage to the blading as the side clearance is very large (about one inch). There is no end thrust since the steam enters and leaves the wheel in a direction at right angles to the shaft. • • • Such sturdy rotor construction makes for long life and low maintenance.

The quick starting Terry alternator unit, shown right, is installed in a completed West Coast station. Normally, the auxiliaries are supplied with power from a house service former. During periods system frequency or in failure of the house service auxiliary load is taken on the Terry unit.

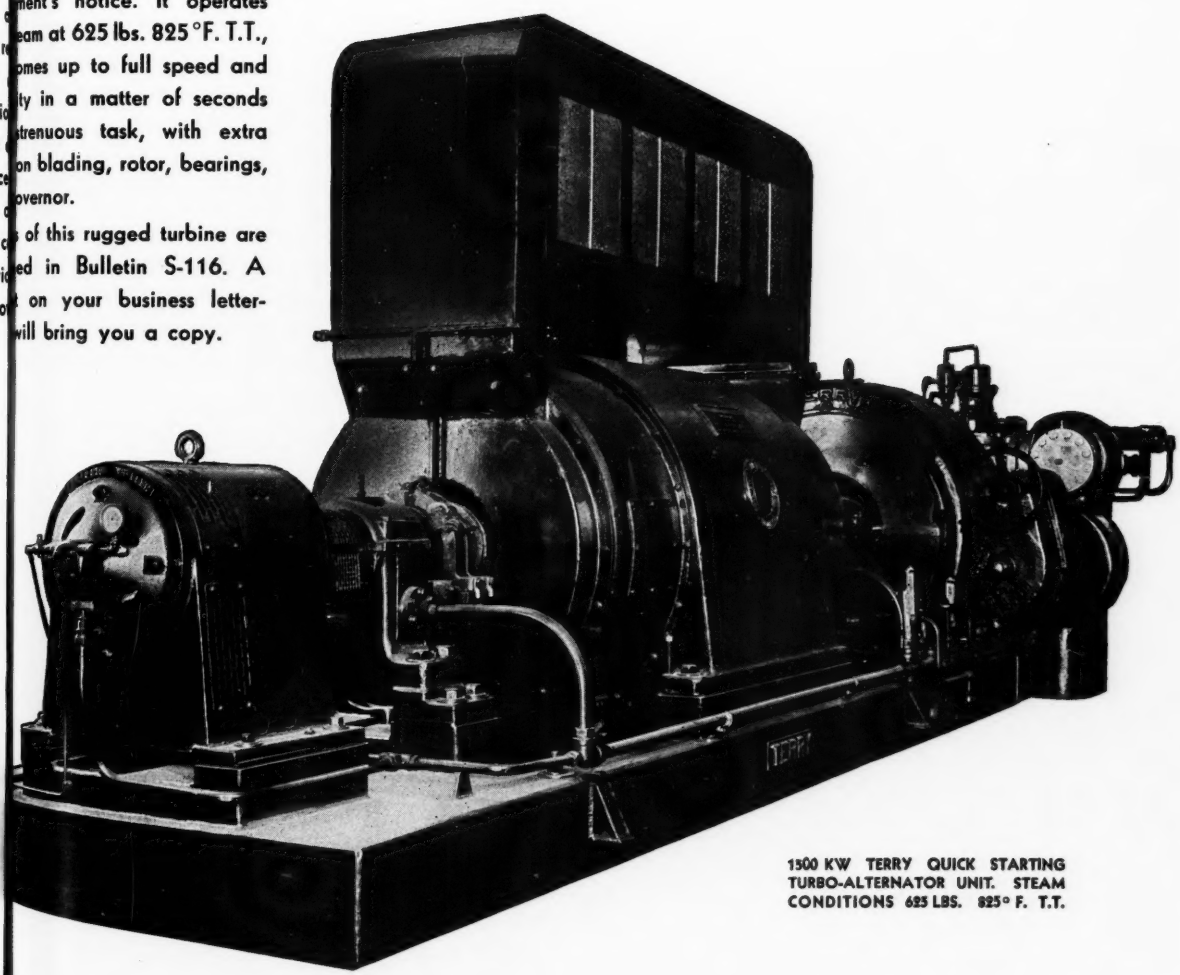
THE TERRY STEAM TURBINE CO.

Wheel Turbine

A500 KW LOAD ON A MOMENT'S NOTICE!

it is ready to take over on ment's notice. It operates eam at 625 lbs. 825°F. T.T., omes up to full speed and ty in a matter of seconds strenuous task, with extra on blading, rotor, bearings, overnor.

of this rugged turbine are ed in Bulletin S-116. A on your business letter- will bring you a copy.



1500 KW TERRY QUICK STARTING TURBO-ALTERNATOR UNIT. STEAM CONDITIONS 625 LBS. 825° F. T.T.

T-1150

TERRY SQUARE - HARTFORD, CONN.

IF IT'S PIPING CONTACT FLORI

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FLORI PIPING

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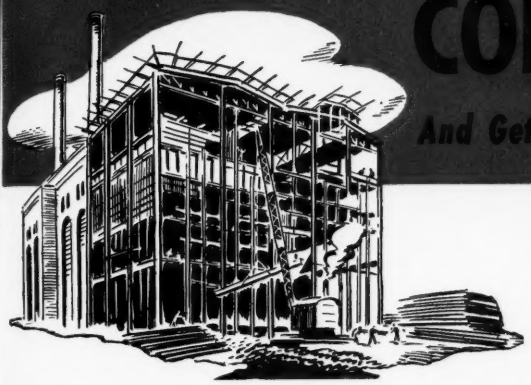
HOW WAR PLANTS ARE SAVING COPPER AND TIME

And Getting BETTER Electric Power Systems



EXPANDING war plants today must get power systems quickly—and yet *save* copper and other materials. Application of the methods outlined here will accomplish both these results—and *also* provide a better-than-ever system. Here's how it is done—

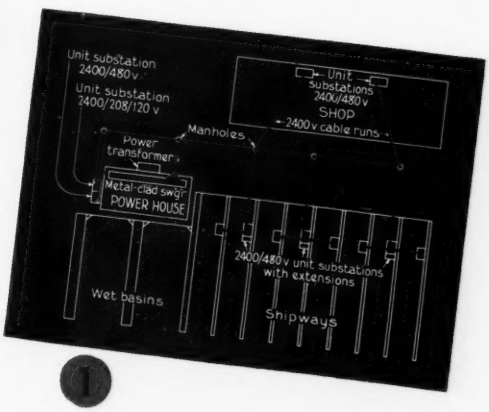
By Using Load-center Distribution

You can avoid long runs of heavy-copper secondaries by running the highest practical voltage direct to relatively small-size unit substations at the *centers* of the load areas, and save tons of cable copper.

Installing substations at the *centers* rather than at the sides of square load areas requires 30 to 40 per cent less copper.

By using four small substations rather than one large substation to serve a square load area, you need only half as much cable copper.

This is both practical and economical with modern safety-enclosed load-center units. These units, consisting of *Pyranol* transformers and *metal-enclosed* switchgear, can be safely installed right in working areas. Bulky, expensive vaults are unnecessary.

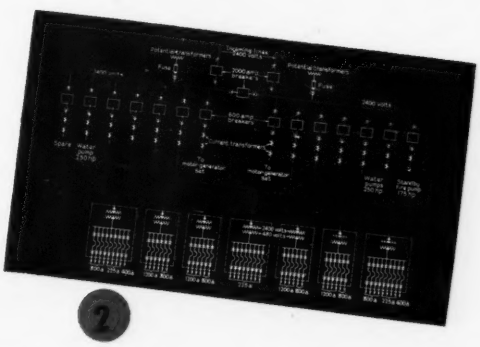


1

High-voltage is run directly to unit substations at *load centers*.

. . . And by Ordering STANDARD SAFETY-ENCLOSED Equipment EARLY

Standard means quick, easy selection and ordering. Safety-enclosed means an exceedingly high degree of flexibility as to location. Together, these advantages enable engineers to provide power in time to meet today's stepped-up schedules.



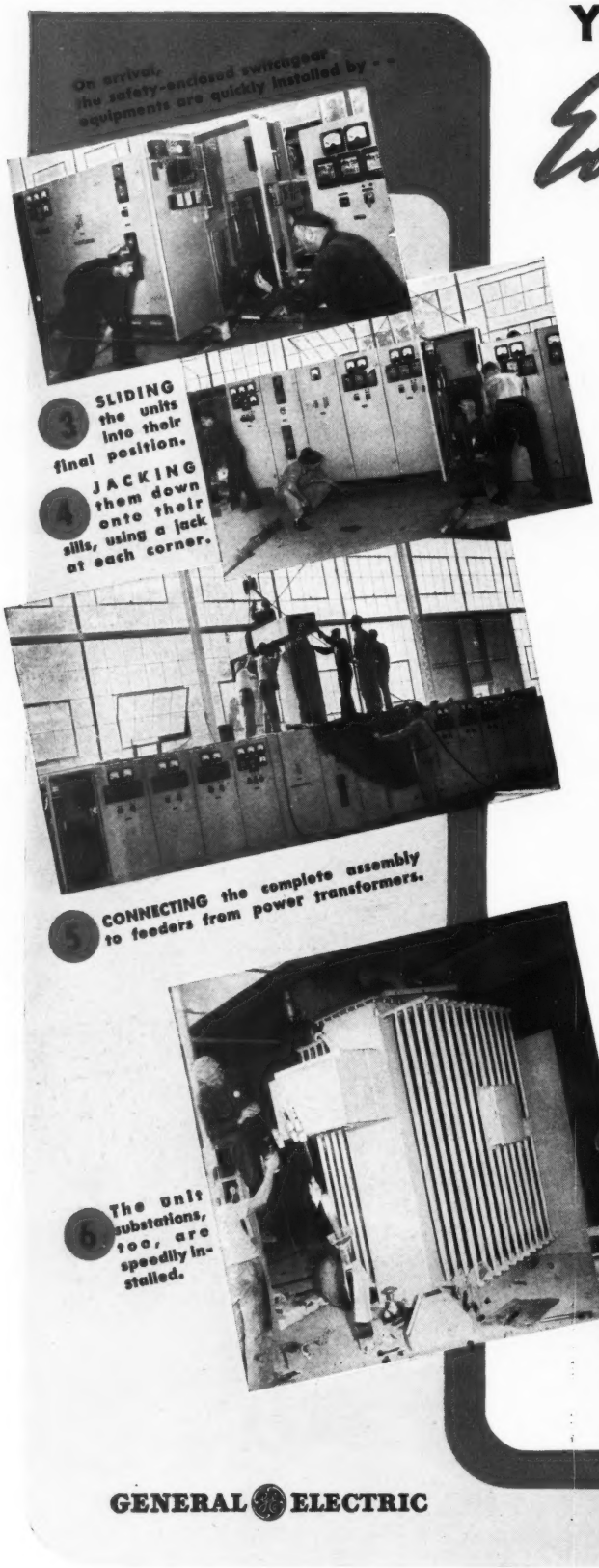
2

A simple one-line diagram is all that is needed for selection and ordering *standard* load-center unit substations and switchgear. This can be done when the plant or extension is in the first stage of construction.

Do This And . . .

GENERAL ELECTRIC

. . . THEN YOU CAN INSTALL YOUR POWER SYSTEM *Early and Easily*


On arrival, the safety-enclosed switchgear equipments are quickly installed by - -
3 SLIDING the units into their final position.
4 JACKING them down onto their sills, using a jack at each corner.
5 CONNECTING the complete assembly to feeders from power transformers.
6 The unit substations, too, are speedily installed.
INDOORS OR OUTDOORS

Safety-enclosed switchgear and load-center unit substations are completely factory-assembled, and are shipped in compact, easy-to-handle units that arrive all ready to be set in place and connected.

THE SAFETY-ENCLOSED SWITCHGEAR CAN BE QUICKLY INSTALLED simply by a "slide, jack, and connect" operation, as shown at the left. Each equipment is a safe, co-ordinated, unit assembly including circuit breakers, buses, and all associated equipment.

Because these compact units dependably perform any desired combination of functions, they save you the extra time and materials needed to select and install open-type exposed switchgear which necessitates long, wasteful copper interconnections.

YOU CAN PUT IN THE UNIT SUBS JUST AS QUICKLY—INDOORS OR OUT. On arrival, the transformer and switchgear sections of the unit substation are moved into position and bolted together. Connections are made to the incoming and outgoing circuits, and the unit substation is ready for service. Flexibility as to location of these safety-enclosed units is such that you can put them right at the load centers. In fact, they can usually be put in relatively valueless space—along column centers, on sub-balconies, and over washrooms.

GENERAL ELECTRIC

EARLY INSTALLATION SPEEDS THE REMAINING CONSTRUCTION WORK——

Compact, standard unit substations —ordered early and installed the flexible, load-center way—have gone into service in scores of new or enlarged war plants weeks before construction was completed. In this way a ready, dependable supply of power is made available for all the power-driven tools and equipment needed to complete the construction. This eliminates the job of improvising a "temporary" power system that often presents a hazard to workers and is subject to power interruptions. It also eliminates a later change-over to the permanent system.

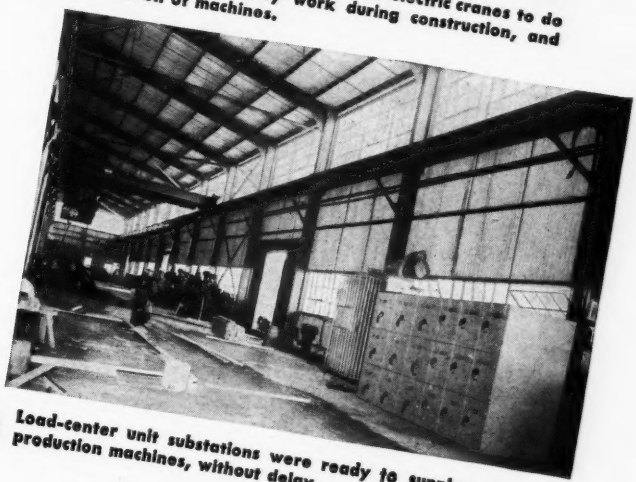
——AND GETS PRODUCTION MACHINES ROLLING AS SOON AS POSSIBLE

Production machines need not stand idle waiting for an electric power system that couldn't be ordered until the building and the exact load locations "took shape." The flexible load-center system easily follows last-minute rearrangement of the machines, and can safely be ordered in time to arrive when needed.

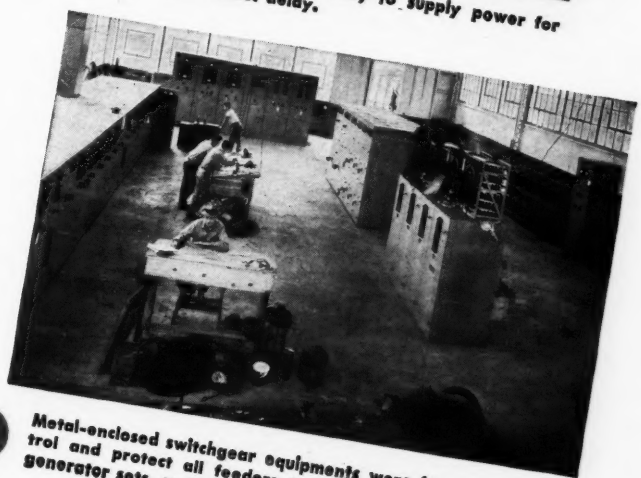
From the very start, you get full protection for both production and personnel. The primary feeders are controlled and protected by metal-clad switchgear equipments so safe that workers can be located near them. Low-voltage feeders from the load-center unit substations are likewise protected by metal-enclosed drawout-breaker equipments that form an integral part of the unit substation.

In this new war plant—

7 The power system was installed in time for electric cranes to do much of the remaining heavy work during construction, and during installation of machines.



8 Load-center unit substations were ready to supply power for production machines, without delay.

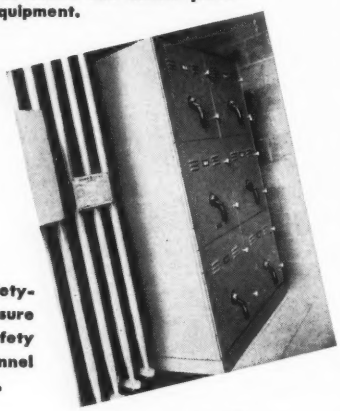


9 Metal-enclosed switchgear equipments were in service to control and protect all feeders to the unit substations, motor-generator sets, and pumps.

Now—ADD UP THE ADVANTAGES

Packaged load-center unit substations GIVE YOU THESE ALL-IMPORTANT SAVINGS

10 **Many tons of copper are saved by distributing power at primary voltage right to safety-enclosed unit substations at load centers—and the complete, permanent electric power system can be installed in less than one-third the time required to select and install piecemeal equipment.**



11 **All units are safety-enclosed to assure permanent safety to both personnel and production.**

12 **The breaker units of all switchgear equipments are easily removed for quick, easy inspection.**

COPPER—When you replace heavy-copper secondaries with small-size primary cables, you save copper by the ton. Consider a 1000-kva, 4160/480-volt unit substation: For every foot that it is moved closer to the load center, you use 1.23 pounds of copper instead of 13.89 pounds. With many units and hundreds of feet, the copper savings soar.

You save copper within the units themselves, too. A typical unit of metal-clad switchgear uses only one-third the copper required by an open-type, piecemeal assembly for the same job.

TIME—In addition to the weeks you save by ordering safety-enclosed load-center units early, you save time by getting standards instead of specials—in a package instead of piecemeal. You avoid the preparation of detailed specifications, and long, drawn-out correspondence, when you select standard, co-ordinated units. You also save time installing the compact, easy-to-handle units.

THEY ARE IDEAL FOR TODAY - - AND FOR TOMORROW

SAFETY AND DEPENDABILITY—Metal-enclosure of all live parts gives increased protection to both personnel and continuous high production in today's busy factory areas.

EASY INSPECTION—Load-center unit substations include drawout-air-breaker equipments that control and protect the individual low-voltage feeder circuits, and quickly restore service with a turn of a handle. The individual breakers can be easily withdrawn for inspection. Similar breaker units are completely interchangeable, so any breaker can be replaced with a spare in a few minutes.

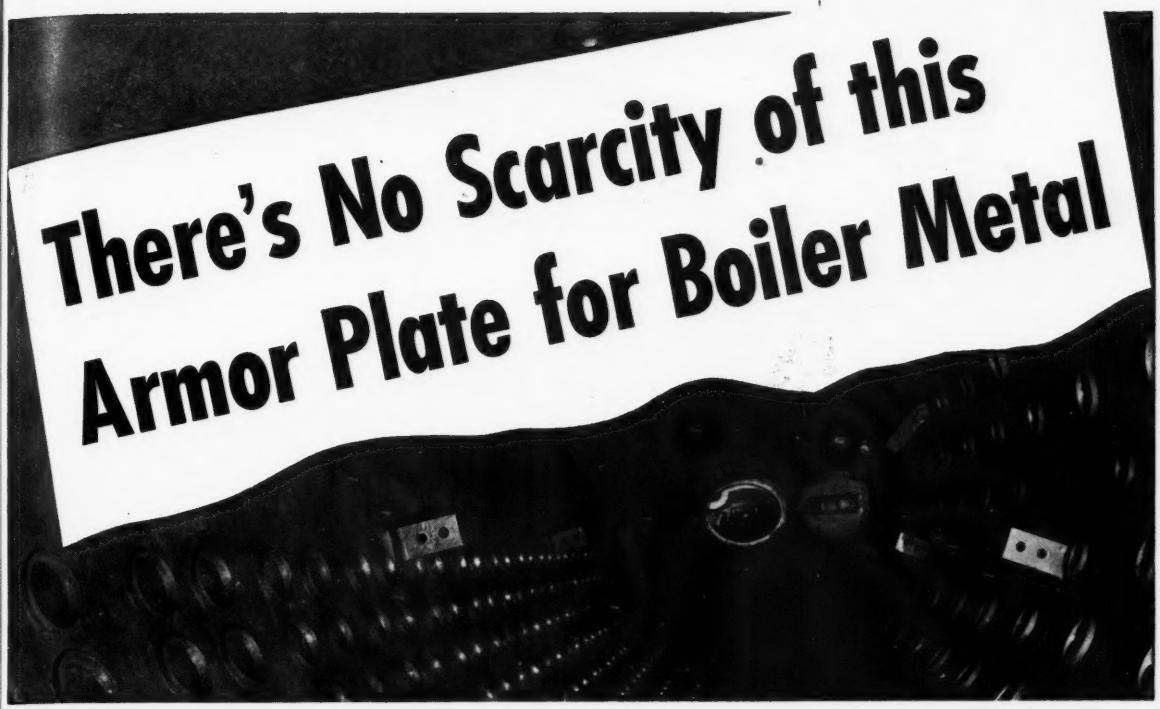
The higher-voltage, metal-clad switchgear equipments (photos 3, 4, and 5) have vertical-lift breaker units that are similarly easy to remove and to replace with a spare during periodic inspection.

FLEXIBILITY—Safety-enclosed load-center units "go anywhere the load can." Their compactness makes them easy to move, too—whether it be a few feet or miles. This flexibility is valued highly by many engineers who realize that they may want to move power units to follow shifting, changing loads.

GENERAL ELECTRIC

Schenectady, New York

There's No Scarcity of this Armor Plate for Boiler Metal



The metal in your boilers is worth its weight in gold, and when worn out, is practically irreplaceable. Yet power demands are increasing every day.

Here's the story of an essential maintenance, repair and operating material that will keep your boilers in service for years to come. It's available. It's economical. It's recommended by boiler insurance companies and endorsed by thousands of industrial power plants, utilities, railroads and marine operators. Even boilers about to be condemned have sometimes been cleaned, found in better condition than suspected, and given extra years of life with APEXIOR protection.

APEXIOR "Plates" Boiler Metal* for Resistance against Wear, Corrosion

Any boiler that can get an O.K. from inspection and a hydrostatic test is O.K. for plenty of war work, because the test strength can be maintained by applying, after cleaning, a durable coating of APEXIOR.

APEXIOR is brush-applied, by hand or power-coater. It forms a tough, impervious barrier against the water, and prevents corrosion for as long as 2 to 3 years (often longer), then can be easily renewed. Scale cannot form a tight bond with the APEXIOR surface — and is quickly removed with a wire brush.

Many more operators than ever before are using APEXIOR, but we have enlarged our facilities in order to help you overcome the problems of metal scarcity. APEXIORIZE — it's the quick, low-cost way of insuring your boiler life.

*Turbine metal, too. Some manufacturers coat shafts and rotor bodies and frequently the interior of casings of all turbines with APEXIOR before shipment to customers.

FREE BULLETINS 1290 (General), 1305 (Marine), Offer Aid to War Service Boilers.

Users like these have applied APEXIOR for years. APEXIOR will help YOU get more service from irreplaceable equipment.

Illinois Central Railroad Co.
Detroit Edison Co.
Hercules Powder Co.
Aluminum Company of America
Union Electric Company of Illinois
Goodyear Tire & Rubber Co.
Utah Copper Co.
General Motors Corp.
U. S. Maritime Commission
Allis-Chalmers Mfg. Co.
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APEXIOR

A Peacetime Plus ★ ★ ★ A Wartime Must

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protective coatings for
STATIONARY BOILERS, LOCOMOTIVES AND STEAMSHIPS

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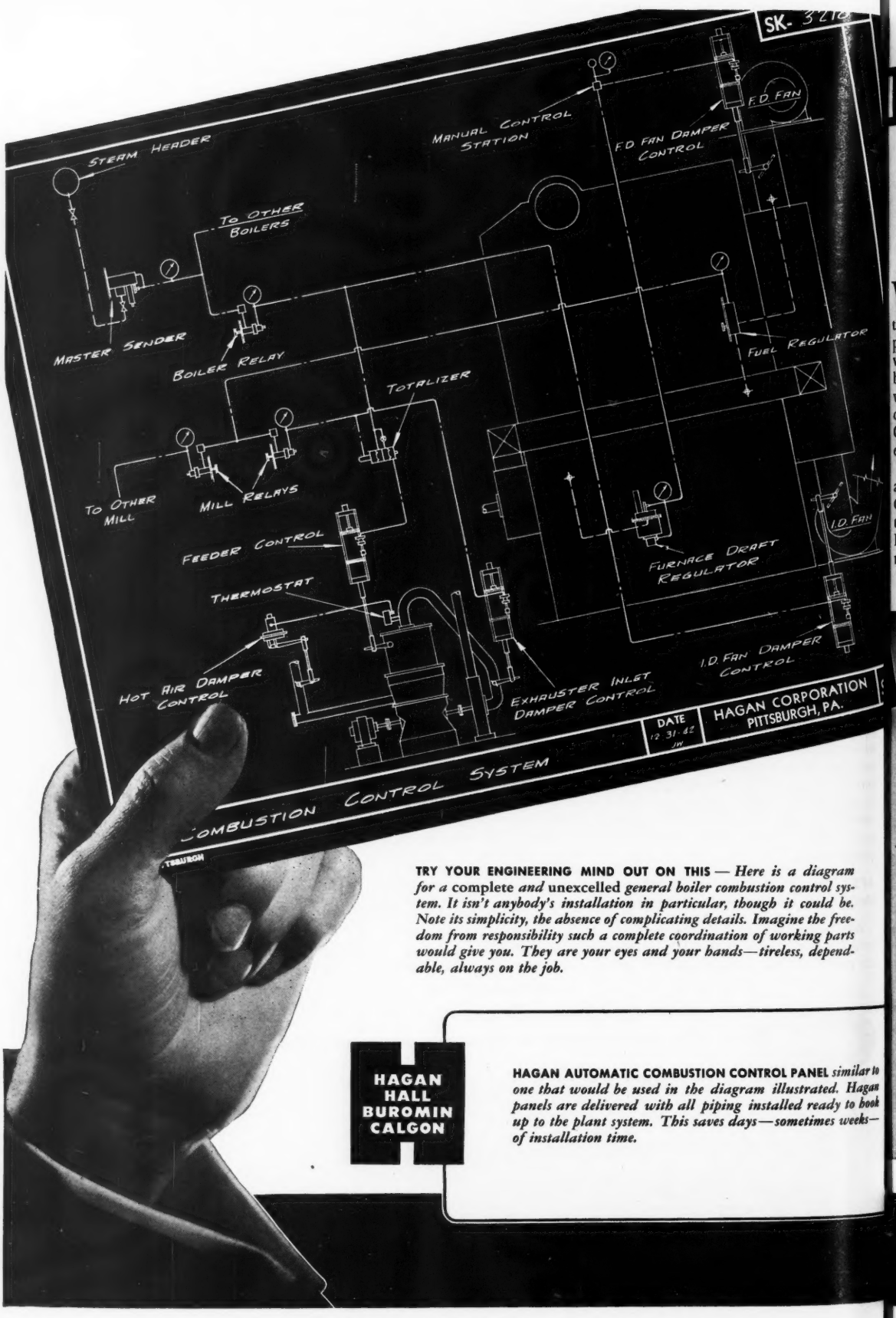


TRY YOUR ENGINEERING MIND OUT ON THIS — *Here is a diagram for a* complete *and* unexcelled *general boiler combustion control system. It isn't anybody's installation in particular, though it could be. Note its simplicity, the absence of complicating details. Imagine the freedom from responsibility such a complete coordination of working parts would give you. They are your eyes and your hands—tireless, dependable, always on the job.*

HAGAN
HALL
BUROMIN
CALGON

HAGAN AUTOMATIC COMBUSTION CONTROL PANEL *similar to one that would be used in the diagram illustrated. Hagan panels are delivered with all piping installed ready to hook up to the plant system. This saves days—sometimes weeks—of installation time.*

Blueprint to successful boiler operation

WHILE the design for a Hagan Automatic Combustion Control installation reproduced here is probably quite different from one which would meet the needs of your boilers, its essential characteristics would be the same. For they are the characteristics which make all Hagan Control equipment distinctive. For example:

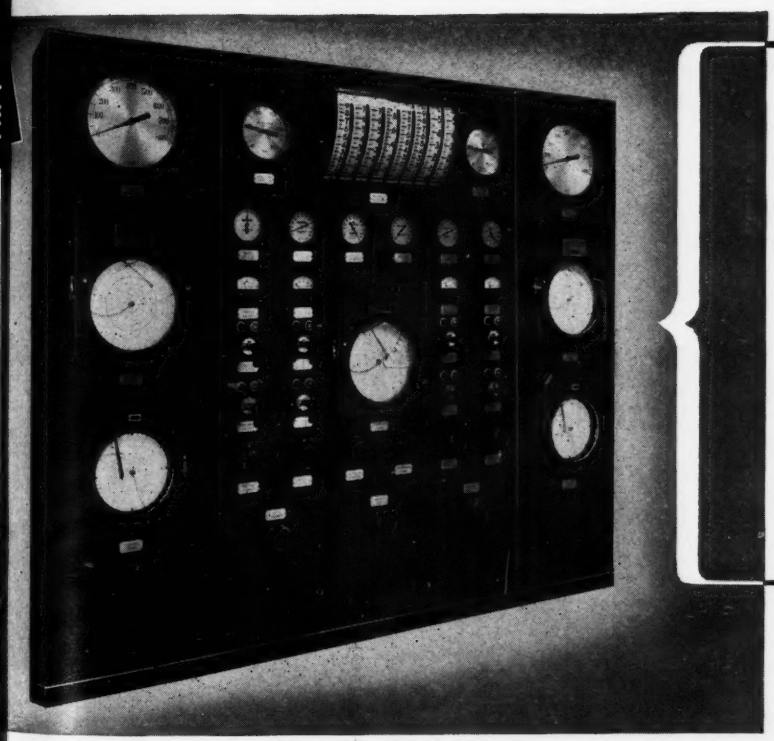
All Hagan Control Systems are alike in their operating simplicity. Ordinary help can easily take care of the largest or smallest installation. Hagan Control is so completely automatic it will operate dependably on its own with little or no supervision.

There would be no installation difficulty on old or new boilers. Hagan Control is so complete when it reaches you that it can be quickly installed without difficulty and in most cases without shutting down the boiler.

Built-in ruggedness has always been a Hagan feature in any of its equipment. Once installed you can look forward to years of uninterrupted trouble-free service.

For other important operating advantages which are definitely Hagan characteristics, you can count on — exceeding sensitivity to load conditions; accuracy of adjustments for small variations; speed of movement, with stability, throughout operating range; flexibility in meeting individual plant conditions. These are products of the engineering minds who pioneered in automatic combustion control and have consistently set the pace for this type of equipment.

Couple these facts with the five maximums promised by Hagan in the accompanying box and you will have the answer to Hagan leadership. Full details on request.



HAGAN CONTROL ASSURES

★ **MAXIMUM** quantity of steam from any given plant, by introducing fuel and air in correct proportion for utmost efficiency.

★ **MAXIMUM** utilization value, uniform steam pressure and temperature, in accordance with demand.

★ **MAXIMUM** output from boilers of differing capacities, automatically.

★ **MAXIMUM** steam for production, by reducing loss of steam in frequent soot blowing.

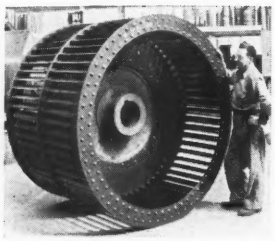
★ **MAXIMUM** protection of auxiliary equipment, fans, stokers, etc. by maintenance of uniform operating conditions.

HAGAN CORPORATION
HAGAN BUILDING
PITTSBURGH, PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

Progress and Power in the S



Wheel of the Sirocco Fan extensively used in the plants of America's vital steel industry.

The prophecy, "Liberty for the World," is being written in steel made in America!

With shattering eloquence, steel is squelching the boasts of the tyrants. More than ever before in the history of America, the future of America and the future of the world depend upon the ability of this nation's steel producers to supply the enormous quantities needed.

America's electric power producers know the importance of steel. And the steel producers are equally aware of the vital need for electric power.

American Blower has had the privilege of supplying Air Handling Equipment of many types, as well as Fluid Drives, for both the Utilities and the Steel Plants.

We feel that the dependable, uninterrupted operation of these American Blower products, in war as in peace, is evidence of the sincerity of our efforts to build only the best equipment of its kind.

ARMY E NAVY

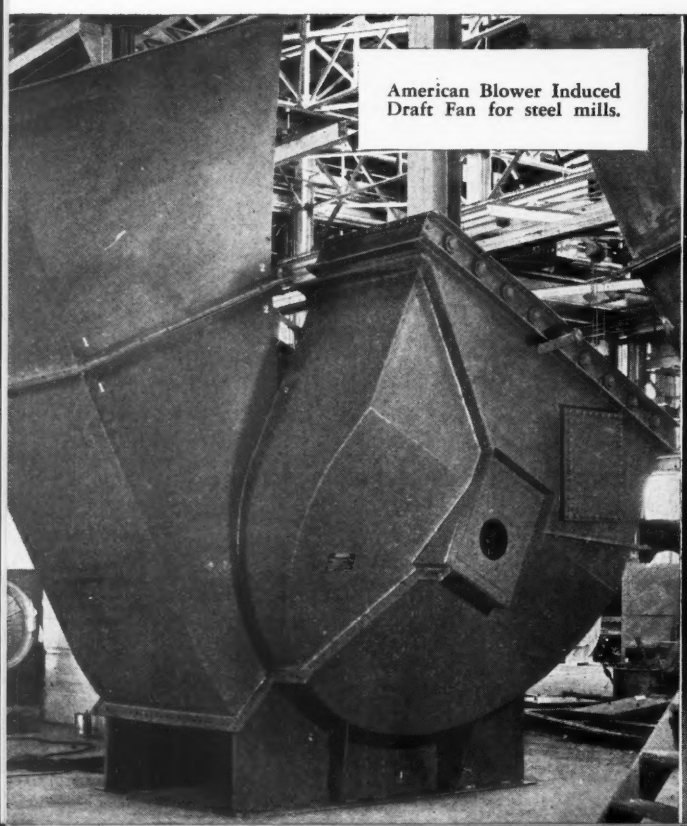
American Blower plants fly the Army-Navy "E."

AMERICAN BLOWER

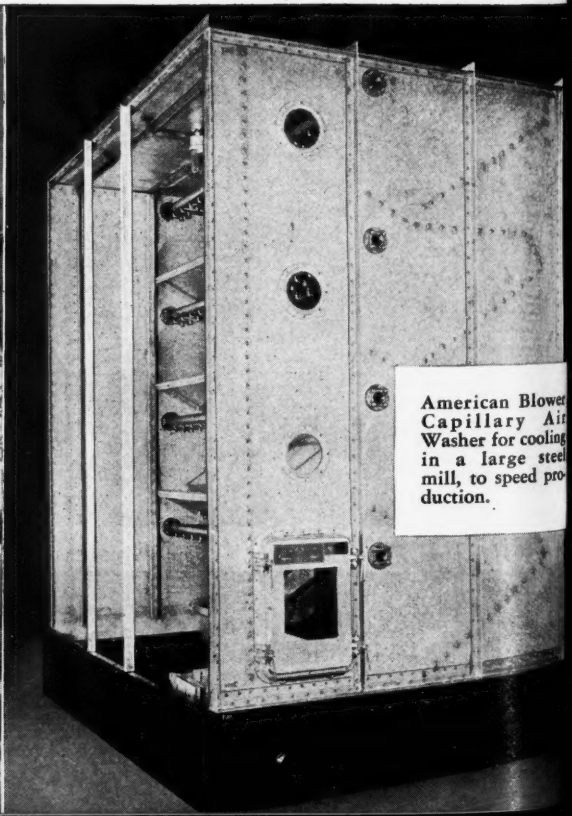
AMERICAN BLOWER CORPORATION, DETROIT, MICHIGAN

In Canada: CANADIAN SIROCCO COMPANY, LIMITED, WINDSOR, ONTARIO

Division of AMERICAN Radiator and Standard Sanitary Corporation

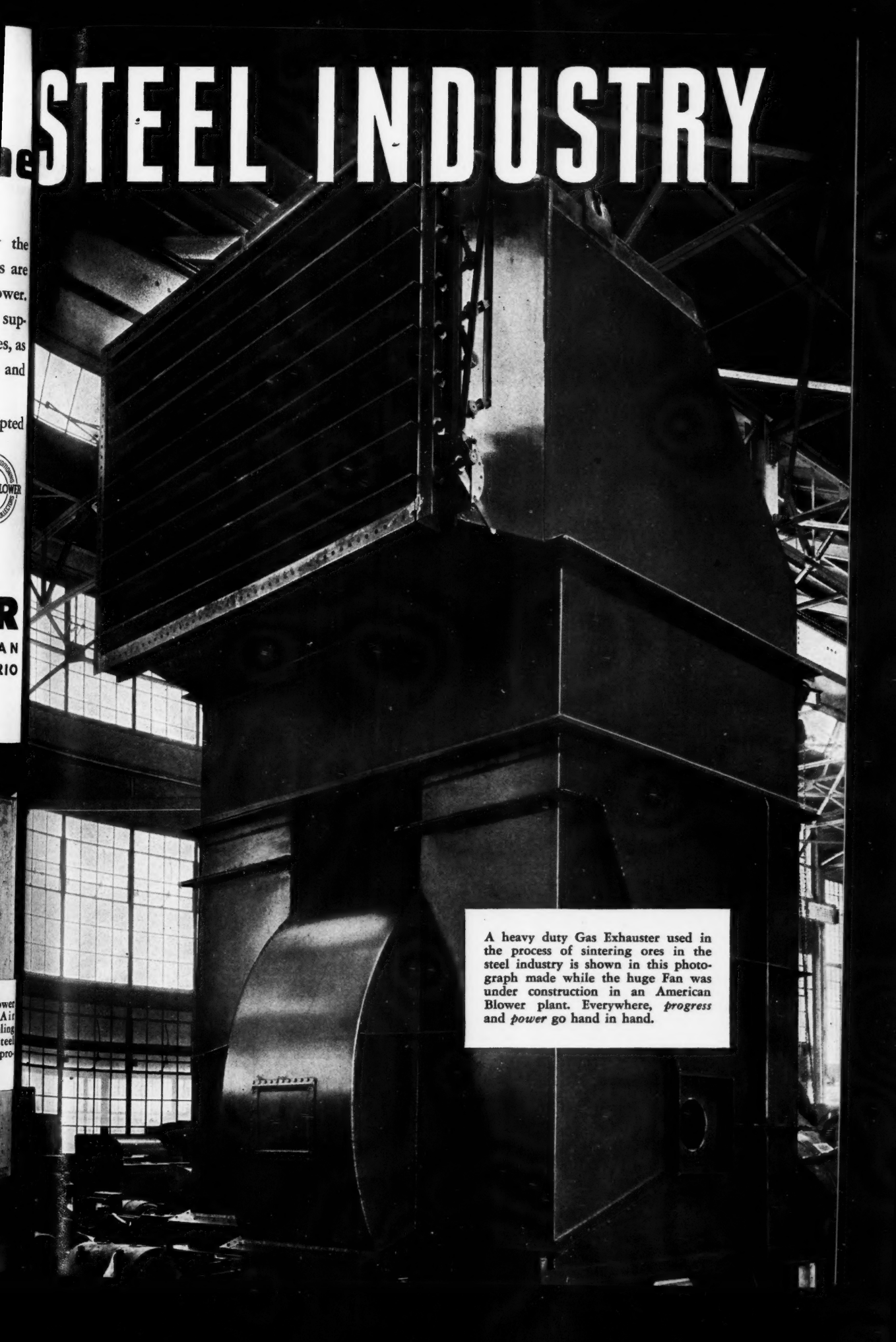


American Blower Induced Draft Fan for steel mills.



American Blower Capillary Air Washer for cooling in a large steel mill, to speed production.

STEEL INDUSTRY

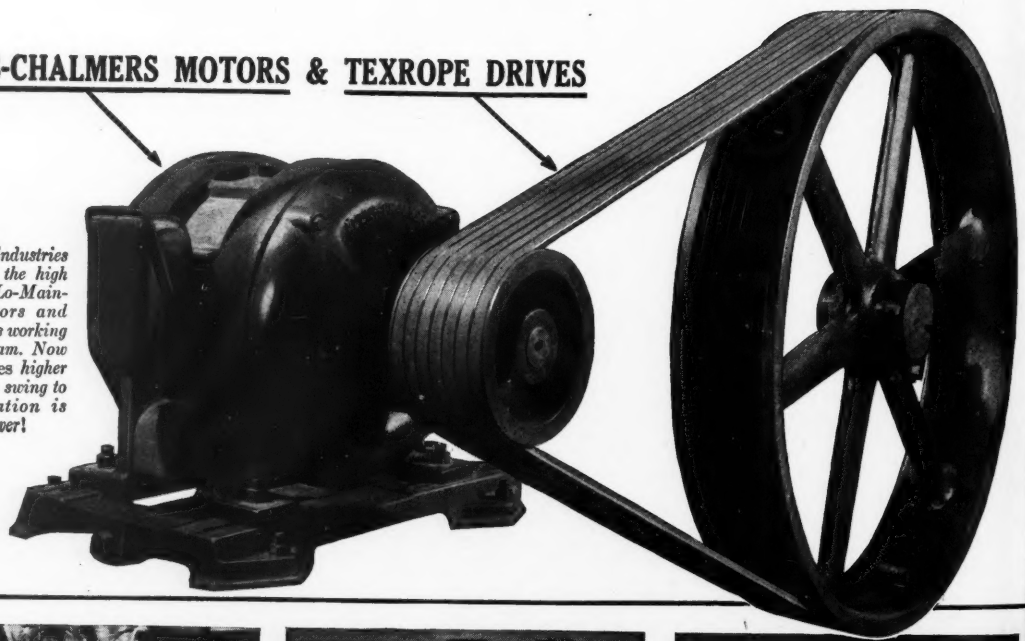


A heavy duty Gas Exhauster used in the process of sintering ores in the steel industry is shown in this photograph made while the huge Fan was under construction in an American Blower plant. Everywhere, *progress* and *power* go hand in hand.

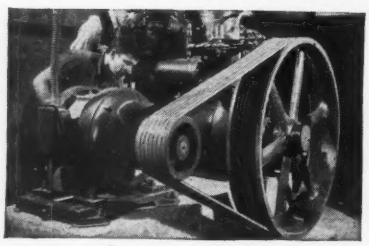
IN PEACE AND WAR--

Give this an "E" for

ALLIS-CHALMERS MOTORS & TEXROPE DRIVES

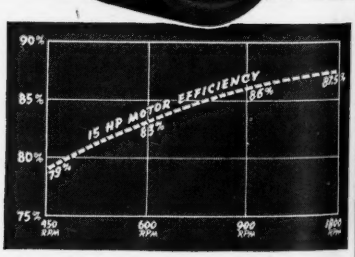


Thousands of industries already know the high efficiency of Lo-Maintenance Motors and Texrope Drives working together as a team. Now that war forces higher efficiencies, the swing to this combination is stronger than ever!



1 In most applications, an 1800 rpm motor with Texrope Drive will ably do the job of a lower-speed, direct-connected motor —at lower cost in money *and materials!*

2 When you buy an 1800 rpm instead of 450 rpm 15 hp squirrel-cage motor, for example, 600 lb are saved. And *you* save well over $200 — with drive figured in!



3 Note that efficiency rises from 79% for the 450 rpm motor to 87.5% for the 1800 rpm motor. The 1800 rpm motor saves you over 30 kw/24 hr. day.

ALLIS-

Combination Efficiency!

☛ **Using high-speed motors with Allis-Chalmers Texrope Drives and single-speed motors with Allis-Chalmers Vari-Pitch Sheaves and Speed Changers has always been good practice. Today it's a vital practice!**

☛ **Such combinations give sharply higher efficiencies —at lower cost in man-hours, money and materials!**

☛ **As America's only builder of both motors and V-belt drives, Allis-Chalmers has long studied and advocated their use in proper combination.**

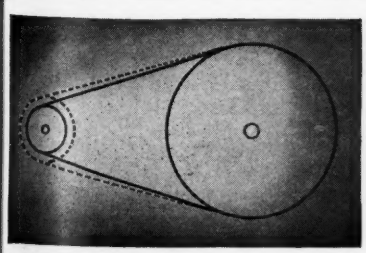
☛ **Today you benefit from Allis-Chalmers pioneering when you ask for—and get—the right combination of Lo-Maintenance Motor and Texrope Drive!**

BUILDING the largest variety of capital goods in the world, Allis-Chalmers know-how is in many ways unique — and is *completely* at the service of American war industry.

Allis-Chalmers, builder of Lo-Maintenance Motors, *originated* the multiple V-belt drive and Vari-Pitch Sheaves.

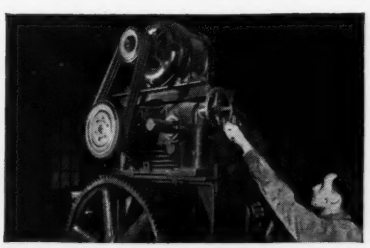
Today there's every patriotic *and business* reason for using material-saving, money-saving single speed and high-speed motors — made flexible and more efficient by Texrope Drives.

Don't hesitate to call on Allis-Chalmers district offices for engineering data or recommendations — or write direct to ALLIS-CHALMERS MFG. CO., MILWAUKEE, WISCONSIN. A 1581



4 Infrequently needed speed changes can be had by changing from one size motor sheave to another. Juggling *complete* drives, range is 1:1 to 7:1.

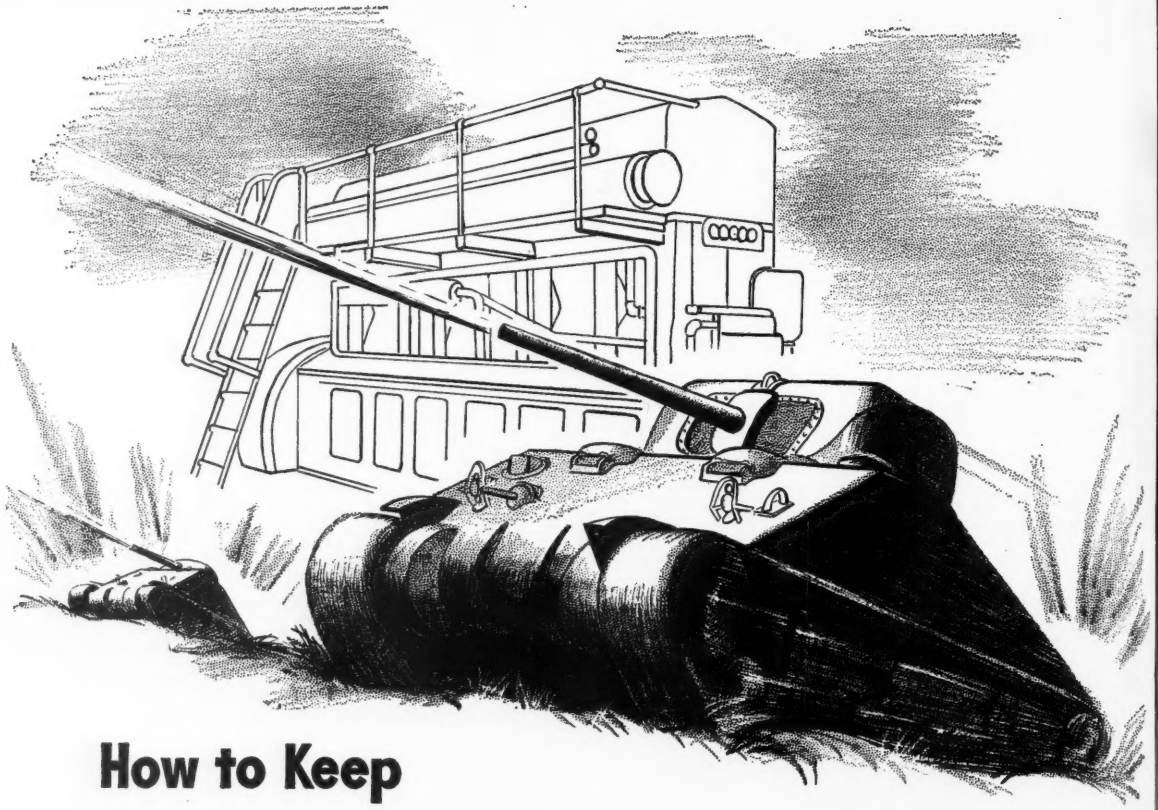
5 With the Allis-Chalmers Vari-Pitch Sheave, you can increase or decrease speed by adjusting sheave diameter . . . obtaining an *unbroken* series of speeds!



6 Allis-Chalmers Vari-Pitch Speed Changer gives you infinite changes at the turn of a wheel — within 3.75 to 1. It's compact, flexible, *efficient!*

A-C ALLIS-CHALMERS

LO-MAINTENANCE MOTORS
TEXROPE DRIVES



How to Keep Your Diesels "FIGHTING MAD"

Today your Diesel is a war-engine. No weapon ever built has meant more in the all-out drive for Victory.

Your job is to keep that war-engine "fighting mad"—to drive it longer and harder than ever before. And, above all, to protect it against breakdown. For, in the total picture of war, a knocked-out Diesel is as critical as a blown-up destroyer.

One of the best ways is to use an oil that has high oxidation resistance—an oil that will not form sludge readily to block the oil passages leading to the bearings—an oil that has a high viscosity index for economy and bearing protection. These properties will be found in Cities Service Pacemaker and Penn-Pacemaker oils. They are particularly suited for the lubrication of large and intermediate size Diesel engines.

Where detergency also is required, as in high speed automotive type Diesels, Cities Service D-C "500*" series oils will be found advantageous.

For further particulars regarding these oils, or for a copy of a comprehensive booklet on "Diesel Engine Lubrication," write Cities Service, Room 1352, Sixty Wall Tower, New York, N. Y.

*Approved by Caterpillar and General Motors.

OIL IS AMMUNITION—USE IT WISELY!

CITIES SERVICE OIL COMPANY
NEW YORK • CHICAGO

IN THE SOUTH
ARKANSAS FUEL OIL COMPANY
SHREVEPORT, LA.

Safer Boiler Operation
Easier Maintenance with

SPECIFY! ERNST FITTINGS

Fig. 4
Standard Type—Offset Adjustable Inclined Gage Fittings

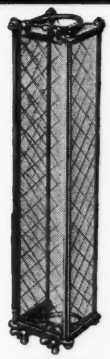


Fig. 9
Wire Glass "Better-C" Guards, All Sizes

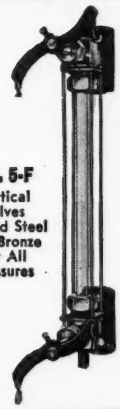


Fig. 5-F
Vertical Valves Forged Steel and Bronze for All Pressures

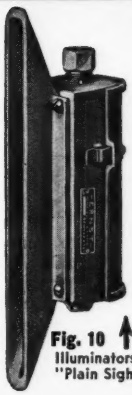


Fig. 10
Illuminators—"Plain Sight"

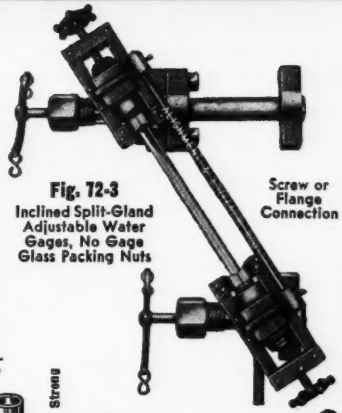


Fig. 72-3
Inclined Split-Gland Adjustable Water Gages, No Gage Glass Packing Nuts

Screw or Flange Connection

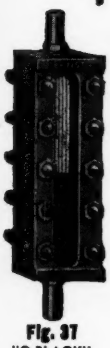


Fig. 37
"C-BLACK" Prismatic Flat Glass Inserts

Fig. 45
"C-Clear Thru" Flat Glass Inserts

Fig. 18 Fig. 19
FLAT GLASSES

GAGE GLASS GASKETS

Standard Pattern Gaskets
High Pressure
Fig. 22

Non-hardening and Non-softening SERIES 750

Send for Gasket Tag showing sizes

GASKETS THAT WILL FIT EXACTLY

Lip-mold Pattern
Fig. 21

Expansion Type Gasket

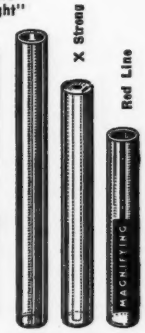
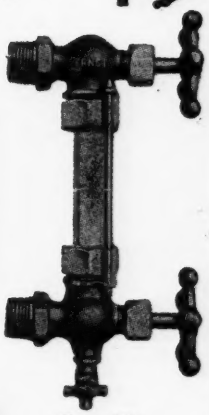
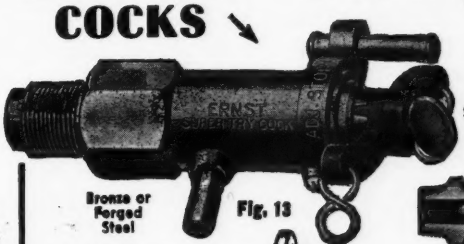


Fig. 12 Fig. 23 Fig. 14



LEAKLESS COCKS



Bronze or Forged Steel
Fig. 13
For All Pressures

Fig. L-150
Steam Metal Bronze Gage for pressures up to 150 pounds

Fig. 18

SIGHT GLASSES for all types OIL CUPS and LUBRICATORS

Fig. 17

SIGHT FLOW INDICATORS for insertion into Pipe lines —All Sizes—

NAVY GAGE

Fig. N-10

For Pressures Up to 250 lb. — This Ernst DCP (Double Chain Pull) Try Cock insures a tight shut off. Order in sets of 3 to complete one water column.

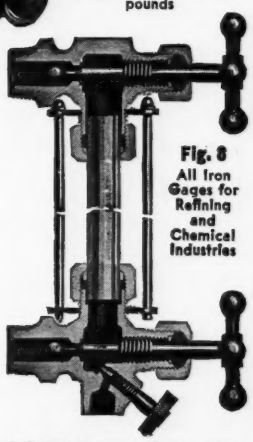
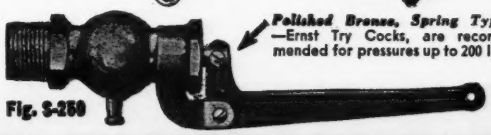


Fig. 8
All Iron Gages for Refining and Chemical Industries



Polished Bronze, Spring Type —Ernst Try Cocks, are recommended for pressures up to 200 lb.

Fig. S-250

We also manufacture..

SAFETY ALARM WATER COLUMNS

FOR ALL TYPES OF BOILERS COMPLETE WITH TRIM

DELIVERIES FROM STOCK
ORDER BY FIG. NUMBERS

SEND FOR COMPLETE CATALOG and State Your Requirements

ERNST WATER COLUMN & GAGE CO.

LIVINGSTON, N. J. *Manufacturing For More Than 35 Years* Phone: Livingston 6-0276

MORE POWER with IRON FIREMAN P.S.* STOKERS

★ PNEUMATIC SPREADER

A Typical Example of Iron Fireman P.S. Performance

Boiler Output Up 41%... Steam Costs Down 30% in Georgia Plant

JOHN M. CLARK
President, Georgia Vitrified Brick & Clay Company

MORE steam, at one-third lower fuel costs, is being produced in the boiler plant of the Georgia Vitrified Brick and Clay Company, Campania, Ga., by Iron Fireman Pneumatic Spreader stoker firing.

Three years ago one Iron Fireman P. S. Stoker was installed to fire two boilers.

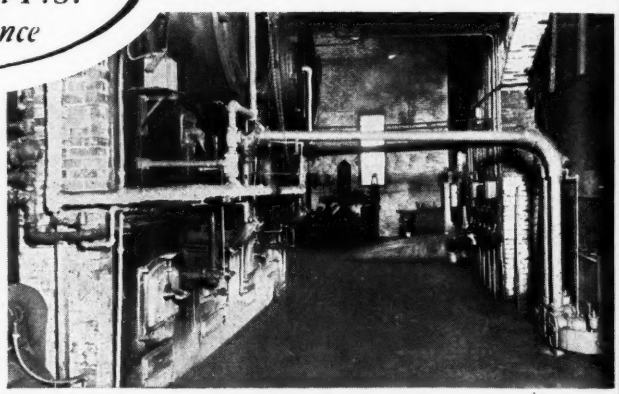
The boilers are H.R.T. welded type, with 1,470 sq. ft. of heating surface.

Boiler tests made before and after the modernization of the plant included these highlights:

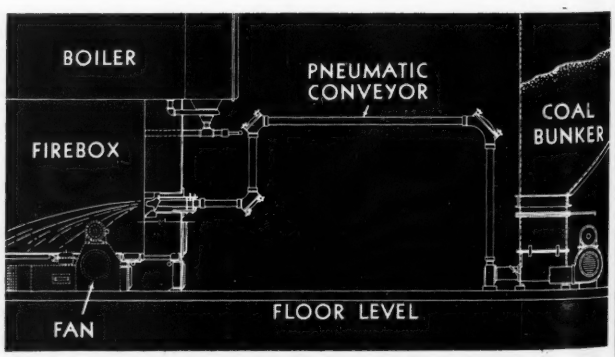
- Evaporation per pound of coal increased 21%.
- Maximum horsepower developed increased from 425 h.p. to 600 h.p., or 41%.
- Cost of 1,000 pounds of steam reduced from 31.2 cents to 22 cents, or a saving of 30%.

Free Book on Pneumatic Spreader Firing

Contains full descriptions, capacities, operating data, etc., with layouts and photos of 10 actual installations. Sent free, on request. Write to Iron Fireman Manufacturing Company, 3514 West 106th Street, Cleveland, Ohio.



One **Iron Fireman P. S. Stoker serving *two* boilers with its dual pneumatic conveying systems. One nozzle enters each boiler. The boilers were quickly adapted to Pneumatic Spreader firing which conveys steam size coal from the main coal bunker to a transfer housing where the coal is picked up by a stream of air and conveyed to the furnace and grates. In this installation no alterations were required of the boiler front except the cutting of two small openings for the nozzles.**



Sketch showing how P. S. Bin-Fed model automatically conveys coal direct from main bin to boiler furnace.

IRON FIREMAN AUTOMATIC COAL STOKERS

A LESSON IN WATER COOLING

LESSON 1 OF A SERIES

PUMPING COSTS

TOTAL PUMPING HEAD is the amount of pressure required to circulate a liquid through a given system. The PUMPING HEAD required for a cooling tower is part of this total head and is that pressure necessary to lift water from the tower's base to its inlet and overcome friction within the distribution system.

The table indicates how very important PUMPING HEAD actually is when measured in terms of operating cost. These costs as tabulated will vary for any given installation in direct proportion to the actual GPM circulated and the power rate in effect.

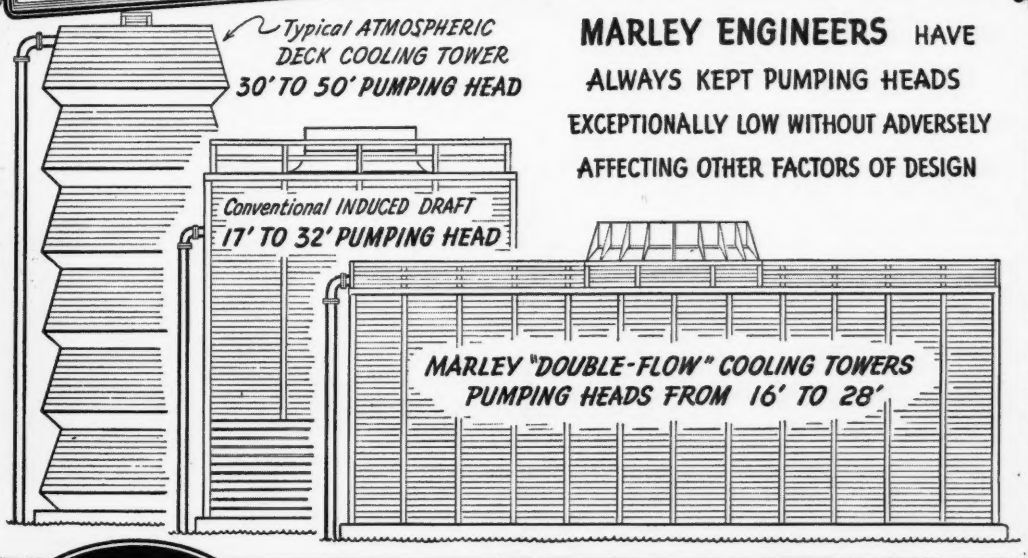
Unlike other tower operating costs resulting from the use of power, pumping head is generally figured on a full-time maximum GPM basis since this constitutes normal operating practice. Therefore any additional or unnecessary pumping head becomes a large factor in the complete comparative cost analysis so necessary for the intelligent selection of a cooling tower.

Relative pumping heads required by cooling towers of different types, designs and "makes" deserve the most careful study and comparison.

Cost Per 1000 GPM

at 1¢ per KWH and 70% Pump-and-Motor Efficiency

Pump Head	24 Hr. Day	30 Day Month	365 Day Year	Five Years	Ten Years
15′	$ .97	$29.10	$354.05	$1770.25	$3540.50
20′	1.29	38.70	470.85	2354.25	4708.50
25′	1.62	48.60	591.30	2956.50	5913.00
30′	1.94	58.20	708.10	3540.50	7081.00
35′	2.26	67.80	824.90	4124.50	8249.00
40′	2.58	77.40	941.70	4708.50	9417.00
45′	2.91	87.30	1062.15	5310.75	10621.50
50′	3.23	96.90	1178.95	5894.75	11789.50


Typical ATMOSPHERIC DECK COOLING TOWER
30′ TO 50′ PUMPING HEAD
Conventional INDUCED DRAFT
17′ TO 32′ PUMPING HEAD
MARLEY "DOUBLE-FLOW" COOLING TOWERS
PUMPING HEADS FROM 16′ TO 28′

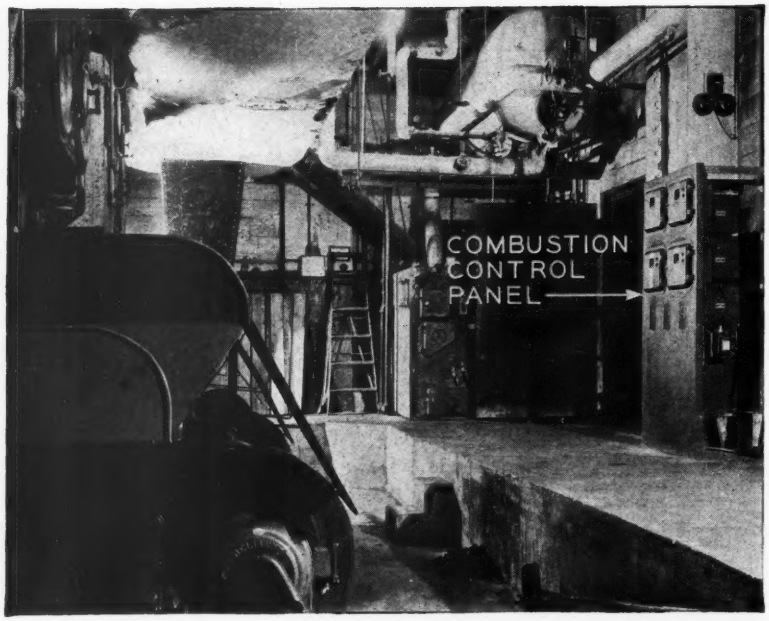
MARLEY ENGINEERS HAVE ALWAYS KEPT PUMPING HEADS EXCEPTIONALLY LOW WITHOUT ADVERSELY AFFECTING OTHER FACTORS OF DESIGN

MARLEY **COOLING TOWERS**

THE MARLEY COMPANY, INC.

FAIRFAX AND MARLEY ROADS — KANSAS CITY, KANSAS

E-43-A



L&N Type P Combustion control installed on three 150 hp horizontal marine type stoker fired boilers. Panel is at right; note its compact arrangement, with the single Master Controller, three Furnace Pressure Controllers, and all Control Stations mounted on panel front. A typical easy-to-install Drive Unit, for uptake damper, is partially shown at left.

SOMETHING NEW
FOR THE BOILER ROOM

The new L&N Type P Combustion Control is a dependable, sensitive equipment designed for plants which do not require the central-station type of control. It is ideal for small plants, and for many of the larger war plants. This Control has the flexibility of big-plant controls, yet is basically the same simple L&N Control used the world over on industrial furnaces. And its cost is minimized by using standard, industry-proved control units. Some of its features are:

A catalog, now in preparation, will be sent when ready to all who request it. In the meantime, those who need information at once, in connection with a war production need, will be given specific facts promptly if they will outline their problems.

Simple; Completely Electric. The feeding of both fuel and air to all boilers is regulated in response to a single Master Controller. This Controller is entirely electrical, and moves the dampers, valves and levers of the fuel-air system by means of electric-motored drive units. The only connection between drive unit and control panel is a single electrical conduit.

Low Cost of Installing. Elimination of compressors, piping and line shafting cuts the labor and time of installing; our factory-assembly of the control panel further reduces installation costs. We can, if desired, supply panel on either individual boiler or group panels. Frequently a boiler board, including both control and instruments, provides a most economical arrangement.

Jrl Ad N-01P-163(1)

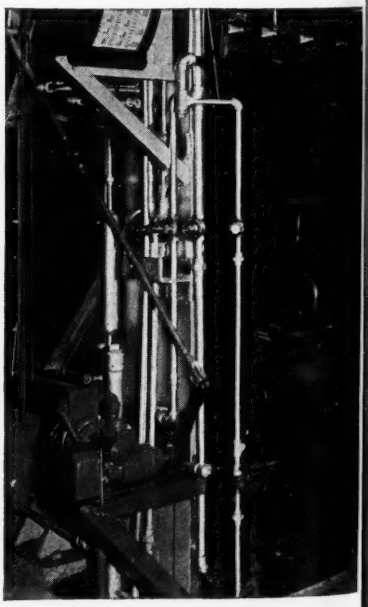
A SLOGAN FOR ALL AMERICANS

Flexible and Centralized. Without moving from the control panel, the operator can switch from fully-automatic control to base-load control or to push-button control; can operate some boilers on automatic control and some on push-button; can change fuel-air ratio of any boiler or boilers. In brief, he can suit the operation to the plant requirements.

Reliable. Control requires only electric power for its operation; which power can come either from 110-volt a-c lighting circuit, or from same circuit which supplies other boiler auxiliaries.

Furthermore, whether on automatic or remote push-button control, the motorized gear reducers cannot be back-driven by an unbalanced damper or equivalent.

Interlocks and other protective features are available.



This electrical Drive Unit is linked to the uptake damper in a cotton mill's power plant. A similar unit is employed for each damper, lever or valve; there are no linkages from unit to unit, and the only connection to the Control Panel is by a single electrical conduit.

LEEDS & NORTHRUP COMPANY, 4973 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

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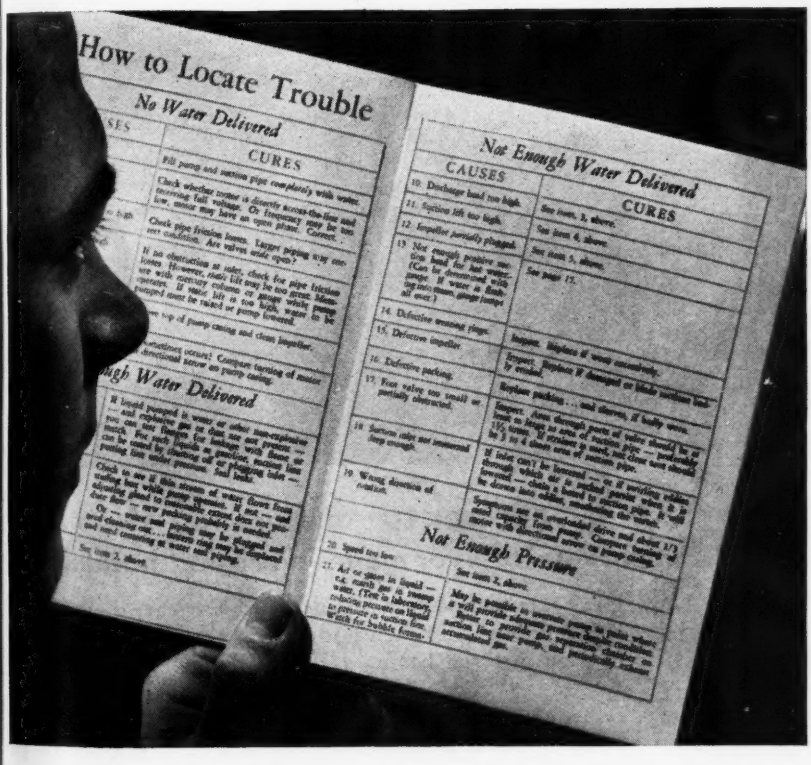
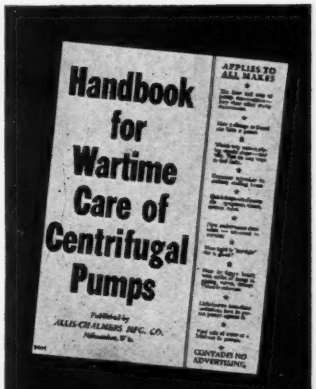


Contains no advertising—applies to all makes — copies mailed free of charge. Suggestion: this new book is particularly helpful for training new men to make present pumps last. When you *do* need new pumps, take a good look at the extra efficiency, ruggedness and long life built into Allis-Chalmers centrifugal pumps . . . all types for every purpose.

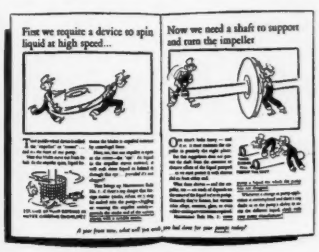
ALLIS-CHALMERS MILWAUKEE

WE WORK FOR VICTORY — WE PLAN FOR PEACE



—AND KEEPING PUMPS OFF THE SICK LIST ISN'T SO EASY TODAY ...NOW THAT MANY ARE DOING 3 AND 4 TIMES THEIR NORMAL WORK!

EVERY "PUMP DOCTOR" in the U.S. should have a copy of Allis-Chalmers' *new* centrifugal pump maintenance guide handy these days. Reason: what was good pump care as recently as 1941 just isn't good enough for 1943. Pumps are working overtime, they're harder to replace — and war production can't afford delays caused by pump failure!



Because wartime pump problems are *new* problems, Allis-Chalmers' new handbook takes a *fresh* look at pump maintenance. A pump is built on paper to review its anatomy. You'll find new preventive maintenance tips, a guide to spotting trouble, new tables. Send in today for *your* free copy!

ALLIS-CHALMERS MFG. CO.
Milwaukee, Wisconsin

Gentlemen:
Yes, I would like to receive free of charge a copy of your "Handbook for Wartime Care of Centrifugal Pumps".

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A-1584-2

INTERLOCKED is One Rod Packing that

Can't Come Apart

TODAY virtually the entire production of J-M Packings and Gaskets is urgently needed for weapons of war, the factories that produce those weapons and the ships and planes that carry them to the fighting fronts. As a result, delivery on other than high-priority orders may be slower than in normal times. However, through increased capacity and a 24-hour-a-day, 7-day-a-week manufacturing schedule, every step is being taken to assure the fastest delivery possible under the present emergency.

J-M INTERLOCKED—*the greatest single improvement ever made in braided packing*

Once Interlocked is installed, you can be sure that repacking jobs will be few and far between. This unique braided material has no jackets to wear through or come apart . . . no plaits to loosen. It is braided square, rather than pressed into shape, and thus presents a better contacting area . . . provides a tight seal with minimum gland pressure and take-up.

J-M Interlocked is provided in a variety of styles to meet a wide range of operating conditions. For details, and for facts on other money-saving J-M Packings and Gaskets, write for Catalog PK-12A. Johns-Manville, 22 East 40th Street, New York, N. Y.

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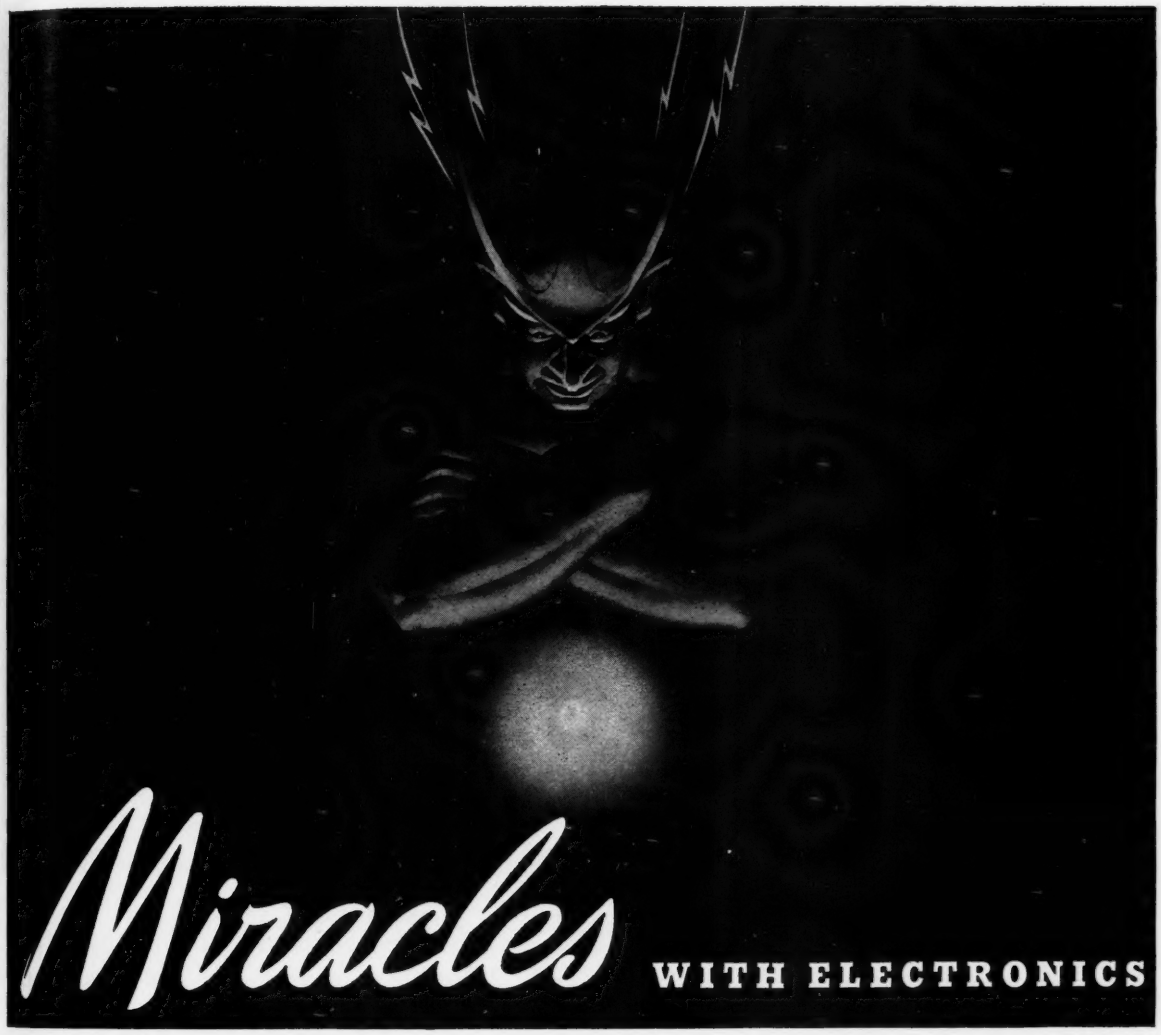
Johns-Manville PACKINGS & GASKETS



Miracles WITH ELECTRONICS

ELECTRONICS bids fair to revolutionize our every day living after the war. When Brown and Minneapolis-Honeywell placed experience and manufacturing resources at the call of our government, the result of several years of research in Electronics was immediately applied to instruments — for Testing airplanes in flight — for Controlling production of high octane gasoline — for Treatment of special alloy steels for tanks, guns and armor plate—for Manufacture of synthetic rubber—and for many other purposes entering directly into the war effort.

Extending this peacetime experience to the technique of war, will bear fruit when Peace comes again, in startling new developments in the Electronic control of industrial processes — busily engaged in peacetime production.

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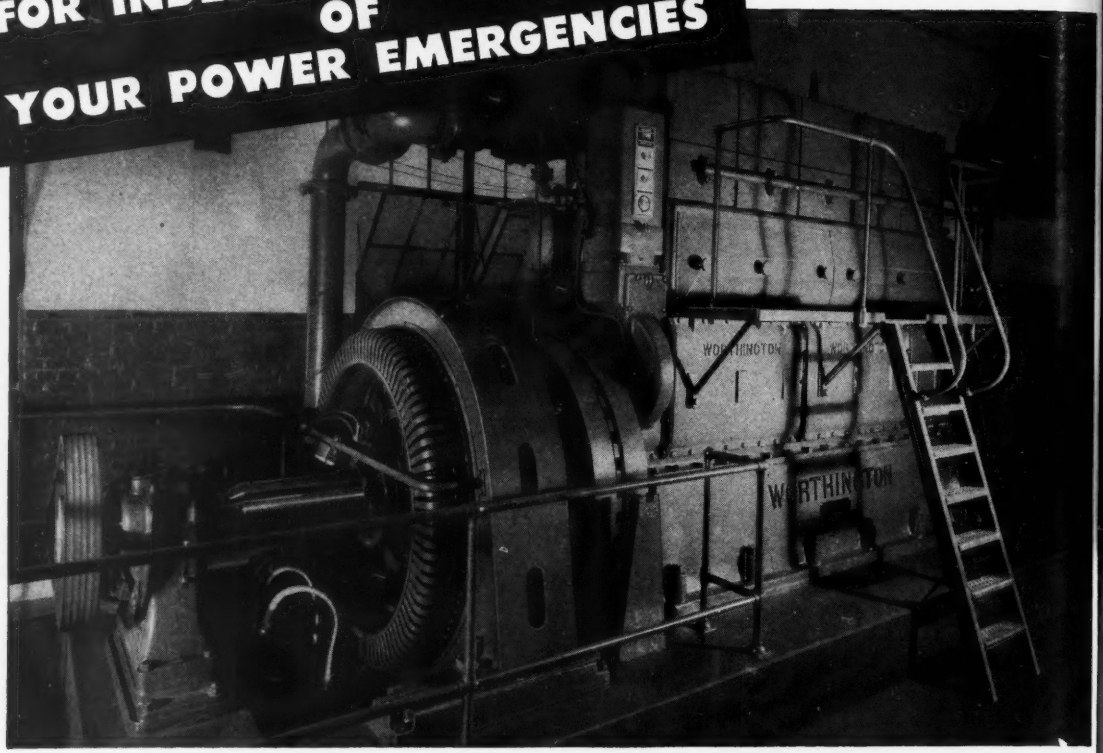
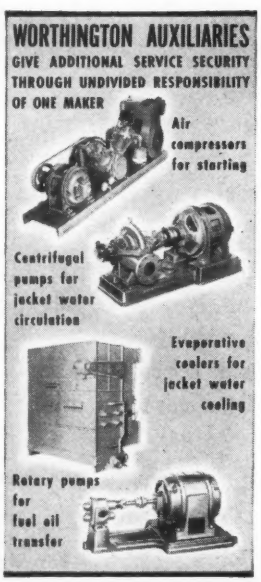
Instruments by **BROWN** *and Controls by*

FOR INDEPENDENT CONTROL OF YOUR POWER EMERGENCIES




WORTHINGTON AUXILIARIES
GIVE ADDITIONAL SERVICE SECURITY THROUGH UNDIVIDED RESPONSIBILITY OF ONE MAKER
Air compressors for starting
Centrifugal pumps for jacket water circulation
Evaporative coolers for jacket water cooling
Rotary pumps for fuel oil transfer

In production, as on the battlefield, war calls constantly for a measure of effort momentarily greater than normal.

When it's additional power that is needed, a Worthington diesel or gas engine-generator unit provides a reliable source, instantly available on call. Such an installation gives you independent control of your power emergencies.

●

Hundreds of Worthington engines are now carrying important parts of the United Nations' war power load.

DIESEL ENGINES
150 to 1500 hp.

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175 to 2880 hp.

CONVERTIBLE GAS-DIESEL ENGINES
150 to 1500 hp.

Both the Navy E and Army-Navy E Awards have been presented to Worthington for speed and excellence in production.

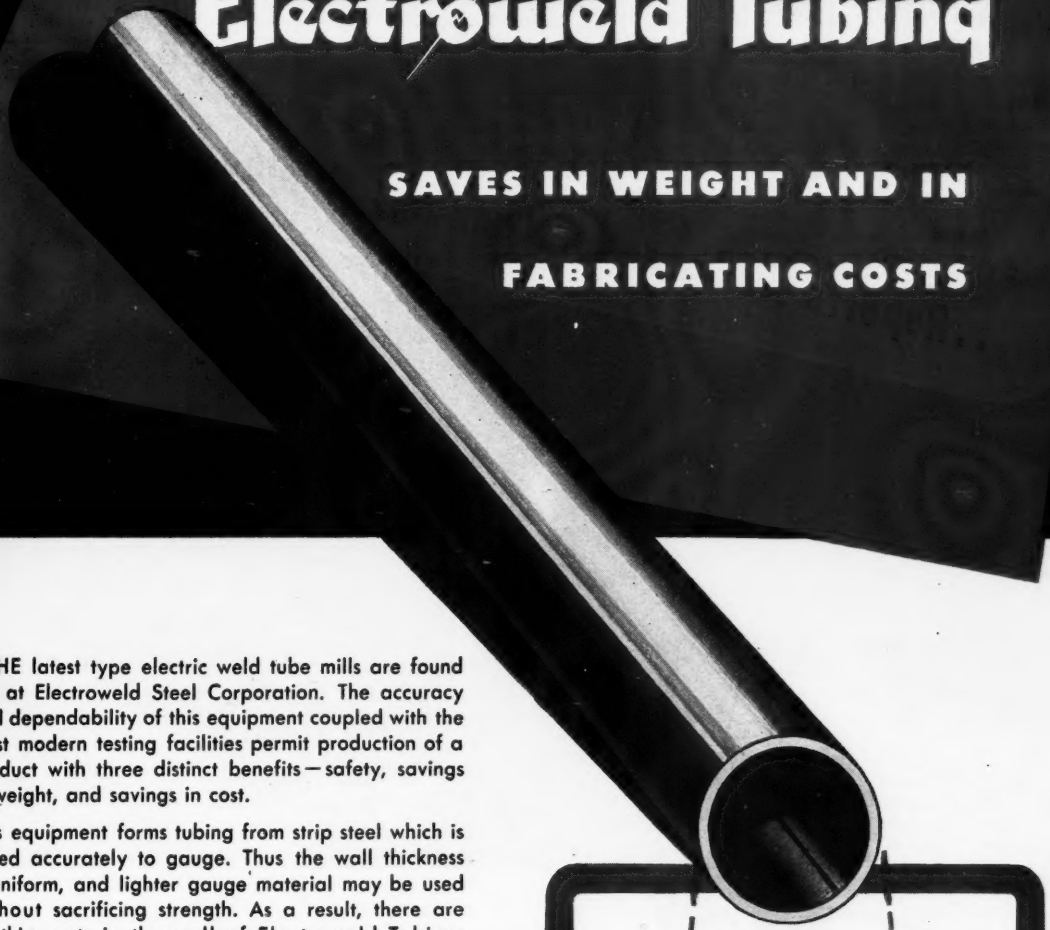
DE3-2

WORTHINGTON

WORTHINGTON PUMP & MACHINERY CORPORATION • GENERAL OFFICES: HARRISON, N. J.

Electroweld Tubing

SAVES IN WEIGHT AND IN FABRICATING COSTS



THE latest type electric weld tube mills are found at Electroweld Steel Corporation. The accuracy and dependability of this equipment coupled with the most modern testing facilities permit production of a product with three distinct benefits—safety, savings in weight, and savings in cost.

This equipment forms tubing from strip steel which is rolled accurately to gauge. Thus the wall thickness is uniform, and lighter gauge material may be used without sacrificing strength. As a result, there are no thin spots in the wall of Electroweld Tubing, and you save weight. The strip steel meets your specifications accurately, and after it is formed into tubing the strength at the weld and adjacent areas will equal that of the strip steel. Every foot of Electroweld Tubing is hydrostatically tested for safety. Therefore, it not only meets your specifications but also Government requirements.

Electroweld Tubing may be adapted economically to boiler, heat exchanger, and condenser installations as well as to mechanical applications since it may be cut, formed, and welded more easily. During the post-war period, you will find it worth-while to consider Electroweld Steel Corporation YOUR source of supply.

Uniform diameter
Uniform wall thickness
Uniform physical properties
Test proven welds
Scale-free, silver-bright finish
Square cuts, minimum burr

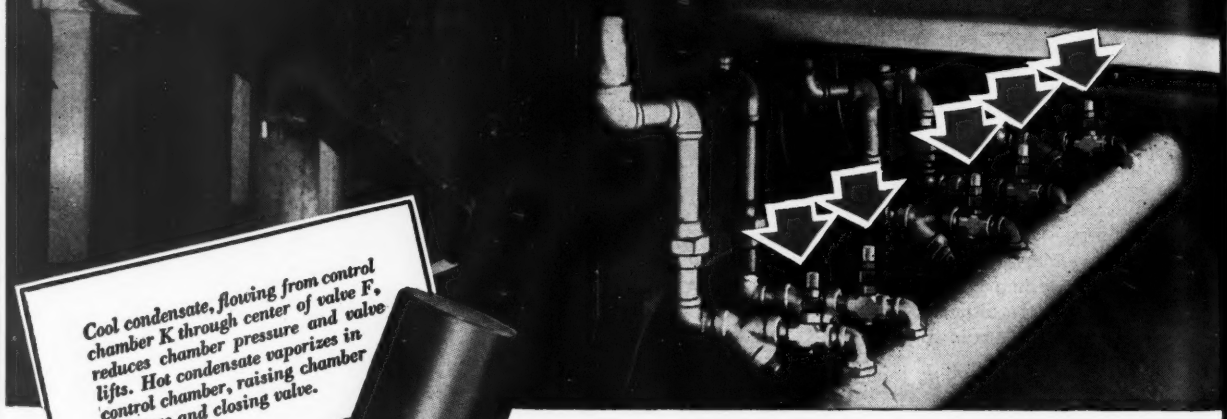
Electroweld

Electroweld STEEL CORPORATION • OIL CITY, PA.

Manufacturers of pressure and mechanical steel tubing

"Our Machines Heat Faster, Stay Hotter with YARWAYS"

..Reports Ambassador Laundry, Oakland, Cal.



Cool condensate, flowing from control chamber K through center of valve F, reduces chamber pressure and valve lifts. Hot condensate vaporizes in control chamber, raising chamber pressure and closing valve.

"YARWAY IMPULSE TRAPS save time and expense, give greater all-'round efficiency. No idle units—no waiting for machines to heat up because Yarways open wide for heavy condensate loads, operate intermittently for light loads."

Why don't you try Yarway Impulse Traps in your plant? Let them demonstrate their *quicker heating* and *sustained heating efficiency*. Let them show you how to *end servicing troubles*, how to *save money on installation, maintenance and fuel* consumption.

Join the purchasers of more than *200,000 Yarway Impulse Traps* who have found out what Yarways *save on the job* and, furthermore, how much *less* they often cost *to buy than to struggle with old ordinary traps* in your plant.

See your Mill Supply Dealer or write for Bulletin T-1737.

YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia

YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

The Engineer and the War

By A. A. POTTER

THE PAST fifteen months have witnessed many changes which are greatly challenging the ingenuity of our profession. Our former abundance of manpower and raw materials now seems like a mirage, as acute shortages have developed which are seriously affecting not only industry but also civilian needs. Engineers and scientists are endeavoring to meet both the scarcity of manpower and the scarcity of materials. They are inaugurating specialized training programs, methods of upgrading, more efficient management, and greater mechanization to meet the problems resulting from labor shortage. They are developing new substitute products to relieve the strain on scarce materials. Furthermore, through better utilization of plant capacity and transportation facilities, they are greatly increasing the quantity of essential materials available for war production.

The public at large is beginning to realize that American engineers can do most with least in the shortest possible time. Never before, in war or peace, have the members of our profession commanded such public respect and exerted such outstanding influence as they do today.

These American engineers and scientists, however, are too few to carry the great task entrusted to them. Although we speak more often about the scarcity of tin, copper, and steel, the fact remains that our greatest shortage is not in materials but in men and women with specialized skills, particularly engineers and scientists, who cannot be trained in a few days or even in a few weeks. The output of engineering colleges, which was barely sufficient to meet the needs of industry during normal times, is falling very short of satisfying the most critical needs of our armed forces and of our war industries.

The War Training program in Engineering, Science, and Management under the auspices of the U. S. Office of Education, through intensive in-service and pre-service courses on the college level, has been most helpful in supplementing the output of engineering colleges by training men and women for industry as assistants to engineers, technicians, inspectors, draftsmen, production supervisors, and commissioned officer specialists for the armed forces. Under this program over 660,000 people were trained or retrained from October 9, 1941, to June 30, 1942, and it is expected that by the end of the present fiscal year, June 30, 1943, the number who have received such training since October 9, 1940, will exceed one and one-quarter million people.

While the War Training Program is meeting a critical need for specialized personnel, the shortage of fully trained engineers for service to war industry and in the armed forces is becoming more acute. The majority of our engineering colleges are attempting to alleviate this situation by operating on a continuous year round or expedited plan, which will make available about a fourth more engineering graduates during the year ending June, 1943.

There is little dependable information concerning the use which the armed forces will make of our engineering colleges. One thing is certain. Our educational institutions of higher learning "will not be taken over by the Government." The Army is planning to send, between March 1 and July 1, 1943, to higher educational institutions, mainly engineering and medical schools, about 150,000 young people in uniform, after these inducted soldiers have completed a 13-week indoctrination training period. The Navy expects to send to engineering colleges about 75,000 people between May 1, 1943, and January 1, 1944.

It is expected that the prescribed program will differ only slightly from the approved normal curricula of engineering colleges, but will be shorter, more specific, and will devote little time to humanities and social sciences. It is expected that the product from the prescribed curricula will not be as well prepared as are our present engineering graduates, although the soldiers sent to colleges will have been carefully selected through certain screening tests, and will have no financial worries, because the Government will pay their tuition and subsistence, in addition to a private's pay of $50.00 per month.

While the above plan will make available a large number of fairly well-prepared engineers for the armed forces, the need for engineers on the part of war industries is bound to become more and more critical. The engineering colleges will, no doubt, be used to capacity for special instruction of value to the armed forces, but unless the war industries make their wants known to our Government, the supply of engineers for industry will be very greatly curtailed. Our war industries will continue to need a steady replacement supply of engineers for the planning, design, and mass production of armaments and other munitions of war. The engineering colleges of our country must continue to be the major sources of this supply.

United action on the part of our profession and particularly by engineers connected with war industries is essential in order to insure an adequate and continuous supply of well educated and thoroughly qualified engineers for service to the war industries as well as in the armed forces of our land. Production of high grade engineering talent does not take place quickly or automatically, any more than does the production of highly complicated armaments.

ANDREY ABRAHAM POTTER, Dean of Engineering Schools and Director, Engineering Experiment Station, Purdue University, has had a brilliant career in the field of engineering education and has exerted profound influence on it.

He was born in Vilna, Russia, came to this country at the age of 15 and was graduated from M.I.T. in 1903. After two years of research work at General Electric Co., he became assistant professor of mechanical engineering at Kansas State College. He was made professor in 1910 and in 1913 was appointed dean of the Division of Engineering and director of the Engineering Experiment Station at Kansas State. He remained there until 1920, when he accepted his present position. He is now chairman of the National Advisory Committee on War Training in Engineering, Science and Management; expert consultant to the U. S. Office of Education; and executive director, National Patent Planning Commission.

As a consultant, Dean Potter has done valuable research on steam at high pressure and temperature and on equipment design, has written engineering textbooks and many articles. He is a fellow and past president of the A.S.M.E., past president S.P.E.E., fellow A.A.A.S. and has been associated with many civic, industrial, and educational societies. In 1940 he received the Lamme Medal of the S.P.E.E. The material presented here is taken from his address following the presentation to him, on February 24, 1943, of the Washington Award.

NUTS FOR THE AXIS

NOT for Mr. Hitler's Axis, however. These bolts and nuts are for the axis of the two latest 75,000-kw. generating units now being installed in the Grand Coulee Dam powerhouse. They are used to couple the sections of the shaft. A set such as this weighs 193 lb., but "they feel like a ton when you lift 'em this way," says C. A. Stewart, Bureau of Reclamation machinist shown in the photograph. The pins are 25 in. long. Before being seated, they are cooled to 80 deg. below zero and shrunk, in a compartment filled with dry ice. While in their contracted form they are inserted in openings in the flanges of the shaft. When their temperature again rises and matches that of the surrounding atmosphere, the fit is as near perfect as engineers are able to make it. This method of fitting bolts by pre-shrinking by dry ice was developed several years ago and has been used with great effectiveness in assembling large equipment, especially hydraulic apparatus

WITH THE EDITORS

◆**WHAT CAN YOU DO UNDER CMP?** . . . When you first look at the CMP regulations, your first impulse may be to acquire a first-class nervous breakdown. Your reaction may be that of many people who quip that the initials stand for Confusion Made Permanent. You may think. "Sufferin' cats! all this legal language, these 'provideds' and 'whereases' aren't going to help me run my plant. Is this all the help I get?"

But take a second look. It's tough going—but get right down to it and really read the rules. Concentrate not on what you *cannot* do under the regulations but on what you *can* do. You'll find, contrary to what you may want to believe, that you can do quite a lot. Also, the WPB is definitely trying to decrease the amount of paper work you have to do. Incidentally, to check your own interpretation of the regulations, we are planning to publish some analysis of them in the near future.

The right attitude to take now is, "Boy! they're certainly trying to make us operate right up to capacity on a shoestring." That's exactly the idea—so that critical materials can go into fighting equipment. What's our plant capacity for, if not to be expendable when we really need it?

So just think to yourself, "How much can I do with what I can get?" You've got welding equipment and machine tools. You've got the brains that brought you this far. You and hundreds of other engineers, in normal times, used those tools to cut production costs when you had to. You just do the same things now for a different reason.

Why, whole plants are being built today out of material originally intended for some other purpose or for the scrap pile. Some engineers we know are making reputations for themselves doing this type of thing.

You're one of the men who has become known to the American people as a group that can do with one dollar what any damn fool can do with five—and in a quarter of the time. You've been doing it for years. That's what makes you an engineer. You can get so interested in beating these wartime handicaps that you'll forget all about having a nervous breakdown.

◆**KEEP THEM RUNNING** . . . The Electric Power Industry, according to no less an authority than J. A. Krug himself, has the distinction of being one of the only industries in which no shortages have developed. Coming from the Vice-Chairman of WPB this statement should be a source of gratification to every man engaged in the power industry and it should inspire him to make every effort to maintain this high standing of the industry. To do this it is necessary that every piece of power plant equipment be kept in perfect running condition.

During the months of April and May some two million kilowatts of installed turbine-generator capacity in the central stations of the country is scheduled for outage for purposes of inspection and overhaul. This is being done with the approval of WPB. By taking this capacity out of service at this time when the winter peak loads are beginning to diminish, and by carefully checking it for possible weaknesses and making such repairs as may be necessary, continued future operation will be assured. It is merely the application of the old adage "A stitch in time saves nine."

Although these two million kilowatts of installed capacity involve only units in central stations, there is no reason why industrial power plant operators should not make similar plans for overhaul, indeed, it is probably more necessary in the industrial plant field than it is in the utility field.

To facilitate the procedure involved in the overhaul and inspection of turbines we present in this issue two articles dealing with turbine inspection and maintenance. One of these describes a specific case, that employed in a plant at Columbus, Ohio, where a badly eroded interior of a large steam turbine casing had to be repaired. The other is a general article outlining the proper procedure involved in the inspection and overhaul of a turbine. This article prepared by R. A. Hake of the Contract Service Department of the General Electric Co. should be of particular interest to the turbine operator since the procedure outlined is based on many years of practical experience.

◆**A LITTLE FORESIGHT** . . . During the past winter, all along the eastern seaboard, oil-burning boiler plants have been converted to the use of coal. In many instances these conversions had to be carried out in the face of great difficulties—shortage of equipment, lack of help, improper design of equipment, etc. In a few cases plants actually had to shut down because of lack of one thing or another. Hindsight is always easier than foresight and it is easy now to point out what should have been done before, yet the fact remains that a little foresight in years previous, could have saved much grief last winter.

Many of the oil burning boiler plants built in the East, particularly in the New England region where no natural reservoirs of oil exist, could easily have been designed to use both oil and coal. Combination burners have been available for years which permit the conversion from oil to pulverized coal in a few minutes' time and if such burners had been installed together with the associated pulverizing equipment, last winter's fuel oil shortage would have caused little trouble.

Naturally, the installation of such coal burning equipment in plants that intended to use fuel oil would have entailed additional investment but in the light of what happened last winter it would have been a wise investment. Aside from the critical conditions imposed by the war, such investments might have been justified by the advantages they might have provided in the purchase of fuel in a competitive market. A user of fuel oil, if he has no provision for using any other type of fuel, usually has no alternative but to accept the price that the fuel oil seller might choose to set but if he is equipped to burn coal as well as fuel oil, he has a distinct advantage—he can always threaten to burn coal.

Wise consulting engineers, those that really had the interests of their clients in view, made every effort to see that plants they designed and built were provided with such combination systems, but there were others who were less conscientious in regard to their clients' interests, and as a result many plants built in New England in the past decade or two, were designed only for the use of oil. These are the plants that had the grief last winter.

Good engineering involves attention to future needs even more than meeting present needs. Usually it requires no great amount of skill or experience to build a plant to meet present needs but it takes skillful analysis and planning to build a plant that can meet the future power requirements of a plant's growth and development.

Strangely enough, in many cases last winter, where oil burning plants were caught short by lack of an alternative means of firing, the "conversion jobs" were awarded to the consulting engineers who originally designed the plants. Apparently, it never occurred to the owners of these plants that the engineers had been remiss in the performance of their work in not urging combination fuel-burning arrangements in the first place.

◆**AFTER THE PIPELINES ARE FILLED** . . . Power plant engineers may need to be a bit shifty on their mental feet during the next few months. Their general situation may not change much but they may have to adjust themselves to changes in details. Here's what we have in mind.

Our war production system has built a number of pipelines to various theaters of war. We are now engaged in filling those pipelines and accumulating the stockpiles behind them. When the pipelines are filled, however, we shall need to put into them at this end only the amounts being drawn from the discharge end.

The boys on the discharge end may tell us from time to time that they need more or less of a particular item. So what do we do then?

Perhaps certain industries, after they are over their production peaks, can make other secondary war products or even products for civilian use. Also, in view of some of these changes, there may be more elasticity in the manpower situation, so that some of our present problems may solve themselves without Governmental action.

In short, right in the middle of our tremendous war production, not two or four years from now, but within a comparatively short time, we may have to do some of the adjusting that we usually think of as post-war planning. Power plant engineers will probably not be much affected by this except in certain details. But they should not be too much surprised if the post-war planning begins to loom up earlier than they thought it would.

Gas Engine Experience In Sewage Service

An operating record of over 38,500 hr. shows Madison, Wis., how to meet its sewage problems and produce power at a cost of 4.36 mills per kw-hr. This is accomplished by gas engines operating from the gas produced by the process of sewage sludge digestion. Both the jacket cooling water and the exhaust gas from the engines is utilized to provide heat for the sludge digesters. The operating cost of this plant is composed only of the cost of lubricating oil, labor and maintenance. Even lower operating costs are expected in the future

By John C. Mackin, Asst. Superintendent of Operation, Madison Metropolitan Sewerage Dist., Madison, Wis., and W. H. Gottlieb

SEWAGE treatment plants are by their very nature well adapted to the use of gas engines as power producers. Sewage sludge digestion requires heat which can be supplied readily and economically from the waste heat supply of engine exhaust gas and engine cooling water. The same process of sludge digestion produces a gas which serves admirably as fuel for the engines. Thus, operating cost resolves itself into lubricating oil, labor and maintenance with the result that the cost of power is far below any alternate source.

The $1,500,000 Nine Springs Sewage Treatment Plant which serves metropolitan Madison, capital of Wisconsin, has placed increasing reliance on gas engines since the first unit was installed in 1937. Madison has the evidence of more than 38,500 engine hours to show that every problem of power production can be met and that gas engines provide a dependable and highly economical source of power.

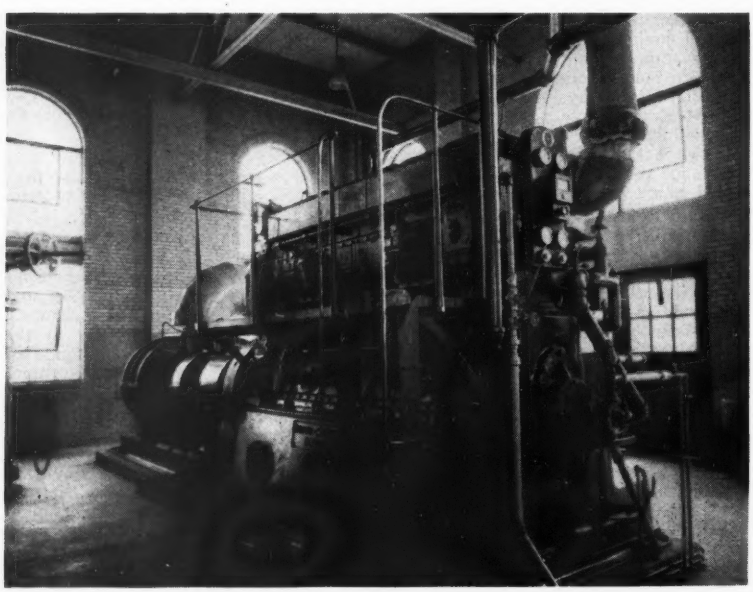


Fig. 1. This closeup of the 320-hp. Cooper-Bessemer gas engine shows the American Bosch magnetos, the gage board with an Alnor pyrometer and the main lubricating oil pump

The Nine Springs Plant uses a dual system of sewage treatment, on the one hand a combination of Imhoff tanks and trickling rock filters, and on the other aeration with activated sludge. In the latter system, with which we are mainly concerned, the sewage, after grit and grease removal and a period of retention in primary settling tanks, is mixed with activated sludge and thoroughly agitated by a supply of purified air. This aeration is accomplished in six tanks, each 135 by 30 ft. with a depth of 15.5 ft. The air is forced up into each tank through 2016 fixed porous plates arranged in three rows. The principal power job at the Nine Springs plant is to drive the blowers which supply this air.

Three Roots-Connersville rotary positive blowers supply all the air for aeration. The power arrangements are highly flexible. A 20 by 13-in. blower with rated capacity of 3300 c.f.m. at 7.25 lb. pressure at 514 r.p.m. is driven by a 150-hp. Electric Machinery motor. A 22 by 16⅜-in. blower rated at 4500 c.f.m. at 450 r.p.m. can be driven either by a 200-hp. Cooper-Bessemer gas engine or a 200-hp. Allis-Chalmers motor. The largest blower, 24-in. by 22-in., rated at 6750 c.f.m. at 430 r.p.m., is driven by a 320-hp. Cooper-Bessemer gas engine. Thus it is possible to supply at least minimum requirements through

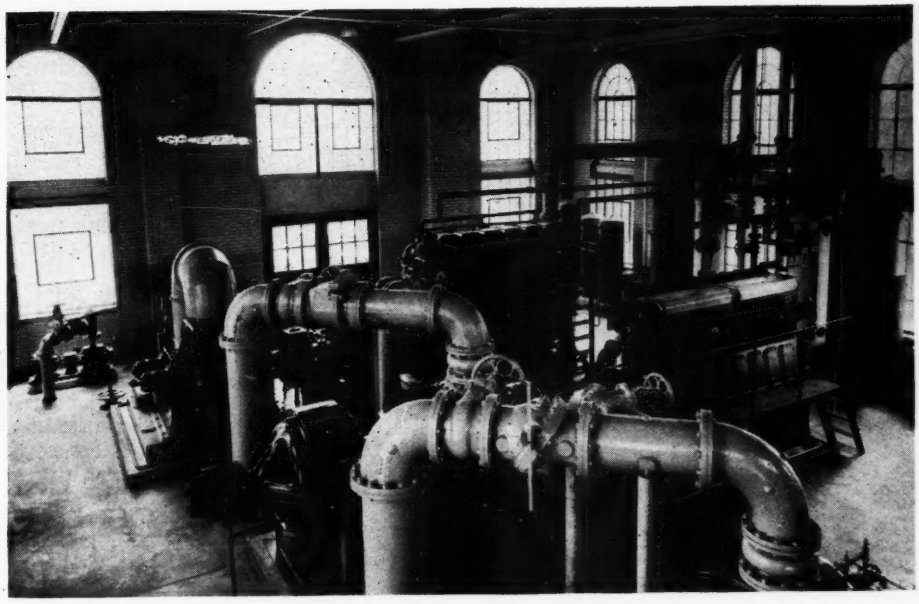


Fig. 2. (Right) This general view of the Madison sewage works engine room shows the two Cooper-Bessemer gas engines, the Roots-Connersville blowers, the cooling water pump at left, the Honan Crane lubricating oil purifier in the center background and the Sims heat exchanger and Burgess snubbers near the wall at the right

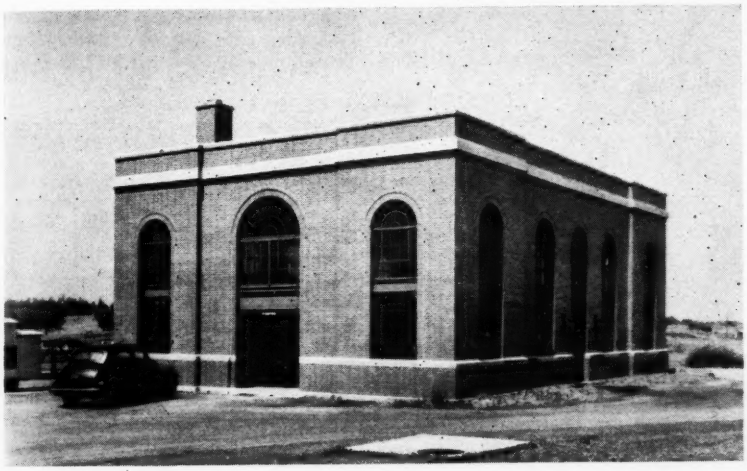


Fig. 3. The Madison sewage power house houses the gas engines, the blowers and accessory equipment

use of purchased power. In practice, however, virtually complete dependence has been placed in the more economical gas engines.

Table I gives the full picture of hours of operation from 1937 when the aeration tanks, the 200-hp. gas engine and blower and the 150-hp. motor-driven blower were put into service. The 320-hp. gas engine and blower and the alternate motor-drive for the 200-hp. unit were put into operation in 1939. The Table shows that use of the gas engines has increased steadily from year to year so that in 1941 there was an engine in operation 97.6 per cent of the time.

The reason for the increasing use of gas engines is a matter of pure economics—Madison finds this the cheapest way to meet power requirements. Five years of operation with alternate sources of power has given plant management an unexcelled basis for cost comparisons. The records show that the 200-hp. motor consumes 143 kw-hr. in an hour of operation at a cost of $1.88. On the basis of power output, it is possible to make an accurate calculation of the purchased power cost of driving the 24 by 22-in. blower. Making due allowance for the lower power rate which would be earned by increased consumption, it is found that the gas engines effect a saving of more than 60 per cent in total power costs.

In 5 yr., engine operating costs have totaled $25,806.16 while the same operations at purchased power rates would have cost $65,108.47. This means a saving of $39,302.31 through use of gas engines. Savings were sufficient to pay the entire cost of the plant in 4 yr. Table II gives the comparative figures for every year since 1937.

The Madison power plant is designed to get the maximum benefit from the trade of waste heat for fuel. Both the jacket cooling water and exhaust gas are utilized to provide heat for the sludge digestors. The water, circulated by a gear pump which is powered by the operating gas engine, leaves the engine jackets at 120 deg. and flows through the shell of a heat exchanger, picking up another 5 deg. from the tubes through which engine exhaust gases pass. The heated water flows through 4-in. piping to the three sludge digestion tanks and then through four coils of 2½-in. pipe inside each tank. From the digestors the water returns to the engines. Here are the temperatures throughout the system:

	Deg.
At discharge from engines	120
At discharge of heat exchangers	125
At entrance to digestors	117
At return from digestors	98
At entrance to engines	95

The exhaust gas from each engine passes through a header to the top of a vertical snubber inside the power plant, down through the snubber and in through a bottom connection to the heat exchanger. Piping is arranged so that the exchanger can be bypassed and gases discharged directly from the snubbers to the final vent pipes which extend through the roof.

The gas produced by digestion of sludge is collected under the

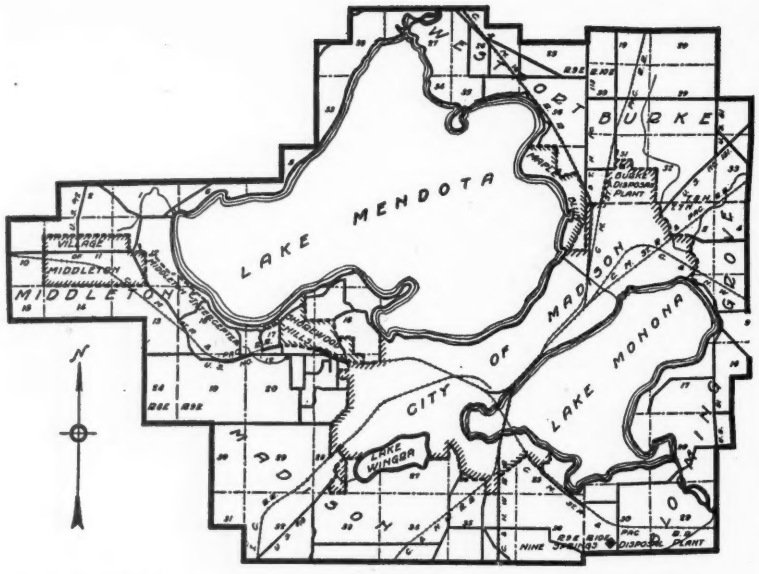


Fig. 4. Map of the Madison Metropolitan Sewerage District showing location of the Nine Springs plant at the lower right

covers of the three digestion tanks and stored in 42,000-cu. ft. gas holders which ride on the two 70-ft. diameter sludge storage tanks. Metered gas production was 28,710,344 cu. ft. in 1941. At the power plant the gas supply line is connected to a mixing valve at each engine where the gas is blended with air and then fed through inlet valves to the power cylinders.

Starting with durable prime movers and a plant design that insured operating economy, Madison solved the problems of operating a gas engine plant in sewage service. The operators faced three major problems: corrosive hydrogen sulfide in the fuel gas, the attendant problem of keeping lubricating oil pure and free from sludge, the scaling conditions that resulted from hard water.

A comparatively high hydrogen sulfide content in the gas threatened serious corrosion of cylinder liners, pistons, heads and valves as well as other deleterious effects. The solution was an iron sponge purifier. Two 8 by 5 by 5-ft. steel chambers were constructed with openly laid 2 by 4's resting on angle irons supporting two layers of iron sponge. The raw gas enters at the bottom and passes up through the iron sponge to the outlet pipe at the top. Radiators on the floor of the tank provide heat in sub-freezing weather. Under present operating conditions, one chamber will serve for about a year, eliminating all hydrogen sulfide from about 18,250,000 cu. ft. of gas. Here are some typical analyses of the fuel showing the effective elimination of hydrogen sulfide after the purifiers were installed in 1939.

Date	Methane Per Cent	Carbon Dioxide Per Cent	Hydrogen Sulfide Per Cent	B.t.u. Net Value
Aug. 16, 1938	64.6	30.0	.644*	580
Sept. 24, 1938	69.0	27.1	.199	619
Jan. 4, 1939	66.7	28.1	.0525	598
June 20, 1939	56.7	34.6	.0162	509
Apr. 19, 1940	64.0	31.8	.0000	573
Sept. 15, 1941	58.2	30.0	.0000	522
July 6, 1942	66.8	30.8	.0000	598

*Of Imhoff tank origin.

The iron sponge is easily rejuvenated by removing it from the purifier trays and forking it occasionally to permit thorough access of air. The used sponge is black when first removed due to the iron sulfide yielded by the reaction. When first exposed to the air the sponge must be thoroughly watered to avoid burning, as considerable heat is developed by the oxidation which follows when the sponge is exposed to the air. Occasional

Table I. Hours of Operation

Year	Gas Engines 200-hp.	Gas Engines 320-hp.	Electric Motors 150-hp.	Electric Motors 200-hp.	% of Time Gas Engines In Operation
1937	6728	....	2021	...	76.7
1938	7075	....	1696	...	80.5
1939	6883	734	1103	33	82.7
1940	5147	3393	33	210	97.1
1941	6118	2428	48	163	97.6
Total	31951	6555	4901	401	86.9 average

Table II. Operating Costs 1937-41

Year	Engine Hours	Total Engine Operating Cost	Cost of Same Operations at Purch. Power Rates	Savings Through Use of Gas Engines
1937	6728	$4,083.34	$10,562.96	$6,479.62
1938	7075	$4,577.46	$11,107.75	$6,530.29
1939	7617	$6,383.82	$12,479.83	$6,096.01
1940	8540	$5,074.01	$15,816.83	$10,742.82
1941	8546	$5,687.53	$15,141.10	$9,453.57
Totals	38506	$25,806.16	$65,108.47	$39,302.31

Average Purchased Power Cost per kw-hr.....11.0 mills
Average Gas Engine Cost per kw-hr..... 4.36 mills

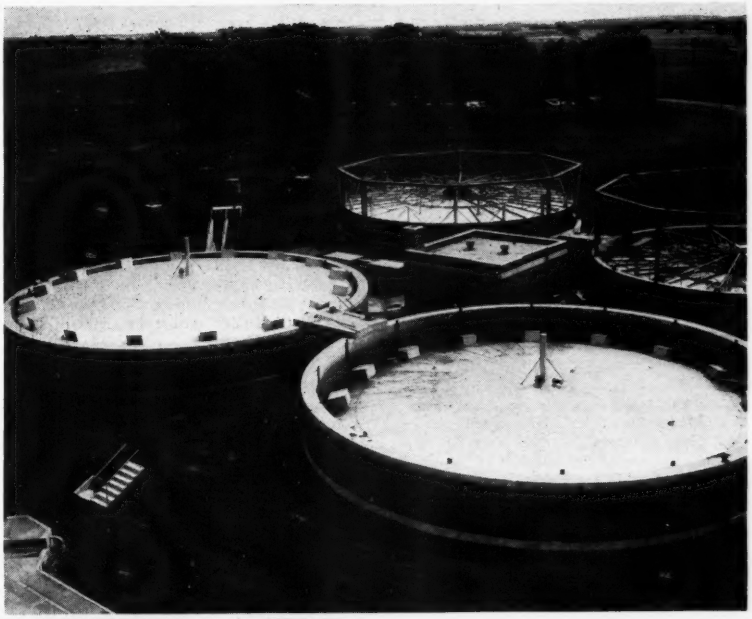
Table III. Gas Engine Operating Data

Date	Engines Operated (hrs.) 200-hp.	320-hp.	Total	Gas Consumption Total	Lubricating Oil (Gals.) 200-hp.	320-hp.	Total
June, 1941	657	62	719	1,918,020	96	3	99
July, 1941	712	31	743	1,932,880	100	..	100
Aug., 1941	730	8	738	1,829,110	103	..	103
Sept., 1941	517	157	674	1,991,850	108	2	110
Oct., 1941	295	361	656	2,249,086	43	47	90
Nov., 1941	300	420	720	2,388,190	38	17	55
Dec., 1941	414	329	743	2,400,860	55	23	78
Jan., 1942	531	179	710	2,143,550	68	14	82
Feb., 1942	446	221	667	2,092,200	56	20	76
Mar., 1942	389	354	743	2,583,960	48	30	78
Apr., 1942	479	209	688	2,061,670	63	16	79
May, 1942	654	17	671	1,699,160	82	8	90
Total	6124	2348	8472	25,290,636	860	180	1040

wetting and forking will bring about complete rejuvenation in a month and the sponge assumes the reddish brown characteristic rust color of the original material.

Two satisfactory solutions were found for the problem of lubricating oil purification. First, oil was withdrawn from the engines and reclaimed in 50-gal. batches. The oil was heated to about 190 deg., then 13½ lb. of Sal-Soda dissolved in 25 gal. of hot water was sprinkled over the hot oil and stirred in over a period of 3 min. Six thorough stirrings at intervals of 5 min. followed. After standing for about a week, the clean oil was withdrawn from the top. This method reclaimed 80 per cent of the oil at low cost, but the job was tedious and it was felt that some system of continuous purification would be preferable. As a result, an activated clay purifier was installed. This unit is in service whenever there is an engine in operation which means practically all the time. Periodic laboratory tests show that the oil is in excellent condition.

By design the cooling water system was immune to contamination, but introduction of the hard city water available to the plant nullified the advantages of a closed system. The solution was achieved in the construction of a cistern to accommodate soft rain water collected on the roof of the plant. In addition, a small quantity of rust eradicator (about ¼ pt.) was added to the cooling water daily. There has always been sufficient rain water for make-up needs and the water system which includes



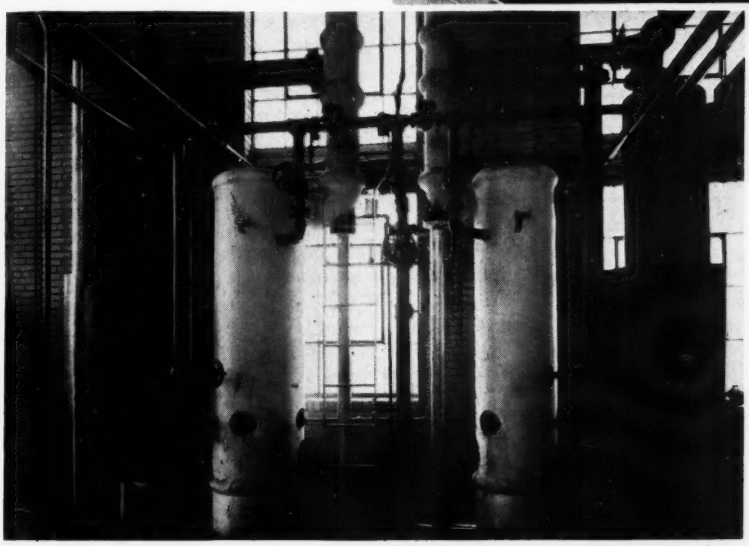
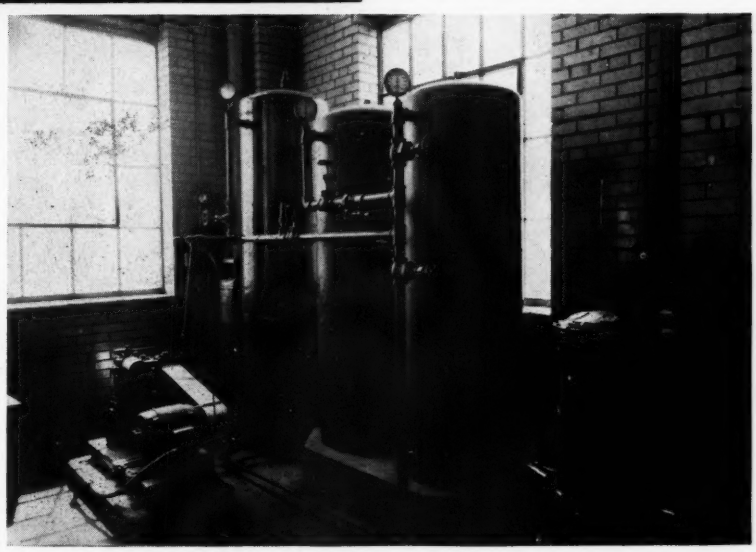


Fig. 5. (Above) This view shows the Graver sludge digestion and sludge storage tanks which produce the gas used for engine fuel. In the center is the sludge control building and the Connelley iron sponge gas purifiers

Fig. 6. (Left) Exhaust gas heat is used to raise the temperature of jacket water leaving the gas engines on its way to heat the sludge digesters. The gas goes through Burgess snubbers and then the insulated Sims heat exchangers which can be bypassed

Fig. 7. (Below) The starting air compressor and the Honan-Crane lubricating oil purifier



Principal gas engine equipment in Madison, Wis., Sewage Disposal Plant.

ENGINES	One 200-hp., 8-cyl., 9 by 10½-in., 450 r.p.m., Model ENG8, 4-cycle, gas engine and One 320-hp., 6-cyl., 11 by 13½-in., 430 r.p.m., Model GNG6, 4-cycle, gas engine. Cooper Bessemer Corp.
BLOWERS	One 22 by 16⅜-in., 4500 c.f.m., rotary positive blower and One 24 by 22-in., 6750 c.f.m., rotary positive blower. Roots-Connersville.
MOTOR-DRIVEN BLOWERS	One 20 by 13-in., 3300 c.f.m. Roots-Connersville blower driven by 150-hp. Electric Machinery motor. (One 200-hp. Allis-Chalmers motor can drive 22 by 16⅜-in. blower.)
FUEL SYSTEM	
Fuel	Sludge digestor gas.
Purifiers	Connelley Iron Sponge & Governor Co.
Magnetos	American Bosch.
Gas Holders	Two 42,000 cu. ft. Chicago Bridge & Iron Works.
LUBRICATING OIL SYSTEM	
Lube Oil	D. T. E. No. 3. Socony Vacuum Oil Co.
Purifiers	Honan-Crane Corp.
HEAT EXCHANGERS	Sims Co.
EXHAUST SNUBBERS	Burgess Battery Co.
EXHAUST PYROMETERS	Alnor, and Brown Instrument Co.
PRESSURE GAGES	U. S. Gauge Co.
SAFETY CONTROLS	The Mercoid Corp.
SWITCHBOARD	General Electric Co.

not only engine jackets but heat exchangers, piping and digester tank coils, is free of scale.

Madison supplements protective accessories with a careful inspection routine. A gage board on each engine holds a multi-point exhaust pyrometer and a set of pressure gages which inform the operator quickly of general conditions in the lube and cooling system. Every day a brief inspection of valve springs and stems and water pump packing is made. Periodically, spark plugs are cleaned and adjusted, magneto points are filed and adjusted, valve tappet clearance is checked and the air starting system examined. Main bearings and connecting rod bearings are checked, a few at a time. Twice each year cylinder heads and pistons are pulled for thorough inspection, and valves ground. The crankcase is thoroughly cleaned and water jackets throughout the engine and around the exhaust header are examined and cleaned.

Careful inspection does not mean that the plant always runs under an operator's watchful eye. In fact, there is no man whose sole duty it is to care for the engines. Most of the time the plant runs without supervision, and so if lubricating oil pressure drops or if water temperature rises beyond predetermined limits, automatic controls ground the magneto, shutting down the engines. In such a circumstance, an automatic alarm wired in series with the controls, summons the operator to the Power Building. There is always a supply of compressed air for starting the engine, for an automatic switch starts the motor-driven air compressor whenever pressure in the three air tanks drops below 200 lb.

The gas engines have been economical power producers from the first, but improved operating methods are increasing efficiency from year to year. Though gas is free, the diminishing consumption attests to engine efficiency. Table III gives figures for the most recent 12-mo. period on the hours each engine operated, gas consumed and lubricating oil consumed.

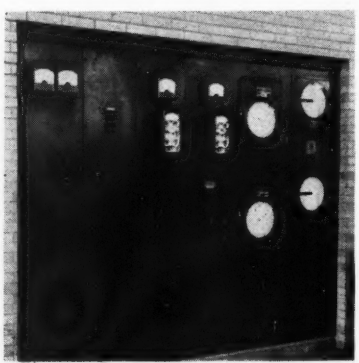


Fig. 8. The General Electric switchboard is equipped with totalizing and recording instruments

After more than 5 yr. of experience, Madison is prepared to recommend gas engines as an effective solution to sewage plant power problems. Gas engine power always has been ready to serve and is used now 97.6 per cent of the time. Gas engine power is meeting Madison requirements at present current cost of about 4.1 mills per kw-hr. and future costs should be lower still.

Absolute Determination of the Ampere

IN MANY TYPES of measurements both electrical and mechanical units are involved. For instance, in a turbogenerator it is often necessary to measure the power input in terms of mechanical and thermal units and the power output in electrical units. In studying the efficiency of such a system, it is important to be able to express all the measured quantities in terms of the units of one system.

Fortunately, this principle was early realized, so that our electrical units are all based on the mechanical units of mass, length, and time. Values of electrical standards were established in terms of these mechanical units nearly three-quarters of a century ago.

However, with improved methods of measurement a demand has arisen for a redetermination of the values of our electrical standards in terms of the mechanical units, giving them more accurate values than were possible by means of the earlier measurements.

For over 10 yr., the U. S. Bureau of Standards has been engaged on determinations of the values of its electrical standards in terms of the absolute values of the units. In the Journal of Research for February (RP1449), Roger W. Curtis, Raymond L. Driscoll, and Charles L. Critchfield describe their work on the standardization of the ampere.

This was accomplished with an instrument known as a current balance, in which the force of attraction between coils carrying electric currents is measured. (Technical News Bulletin 265, May, 1939). The force is measured by comparing it with the gravitational force on a known mass by means of the sensitive balance.

Using the measured dimensions and the force, the value of the current in absolute units can be computed. This same current is measured in the international units, and thus a comparison between the two systems of units can be made. From such measurements it has been established that the absolute unit of current is larger by 150 parts in a million than the international unit.

Expediting Inspection and Overhaul of Steam Turbine Generators

During the months of April and May some two million kilowatts of installed turbine generator capacity is scheduled for outage for purposes of inspection and overhaul. To reduce the outage time to a minimum, operators will do well to read carefully the instructions presented here by Mr. Hake. His suggestions may prevent many headaches and will help to keep equipment running

By R. A. HAKE Contract Service Dept., Lynn River Works, General Electric Co.

PROPER inspection and maintenance reduces outages, guards against hazardous operation, and aids in securing the maximum possible steam economy from the unit. A recent article* pointed out methods of determining when a turbine overhaul is needed by analysis of efficiency and stage pressures. Another article** pointed out that maintenance can prevent accidents. The present article contains suggestions which may be helpful in expediting the inspection and overhaul of steam turbine generators.

Preparing for an Inspection

Careful preparation for the scheduled inspection should be made in advance, and a competent field service representative should be obtained from the turbine manufacturer to supervise the work. Inspection data, such as instruction books, drawings, governor setting diagrams, and previous inspection reports should be secured and made available to the inspector. A tabulation of past operation difficulties to be corrected during the overhaul should be made up. Any repair parts to be installed should be cleaned, inspected, and checked to see that no parts are damaged or missing. Rigging, blocking, tools, and special equipment required for the overhaul should be obtained and placed in first-class condition. Careful planning prior to the overhaul will save outage time.

Inspection Records

The importance of carefully recording the condition of the various parts inspected cannot be overemphasized. It is only through accurate inspection records that the deterioration rate of the various parts can be determined, and this is an important factor in the scheduling of future overhauls and in the ordering of replacement parts. Records—including sketches, templates, wax impressions, and photographs of defective or deteriorated parts—when sent in to the turbine manufacturer, assist in determining the proper replacement material and also aid in making recommendations for repairs. Accurate records of deteriorated parts often are of assistance in obtaining priorities for replacement parts. Many inspection reports contain only the inspector's opinions or conclusions and fail to include the basic facts. Such reports fail to provide valuable records of actual conditions. There is no substitute for accurate facts.

Steam-Path Parts

The condition of the steam-path parts is of first importance. Erosion or corrosion of buckets, blades, or nozzles can be recorded accurately by the use of sketches, templates, wax impressions, or photographs. If the cross-sectional area of these parts has been materially reduced by erosion or corrosion, hazardous operation may result. Erosion of buckets, blades, or nozzle partitions produces sharp corners having high stress concentration which may result in the starting of cracks. Therefore, these sharp, eroded edges should be removed. Corroded and dirty steam-path parts should be cleaned to assist in location of cracks, to reduce the thrust load, and to improve the steam economy. Samples of deposits should be taken for laboratory analysis which may result in reducing further deposits or in the development of a method for removing the deposits without having to open the turbine. The exact location of the deposits in the turbine should be recorded. Cleaning

Fig. 1. Fly ash removal of deposits from the rotor of a large steam turbine. This is the most effective means of removing insoluble deposits such as silica. Fly ash is fed into the jet of air in amounts similar to the amount of sand used in sand blasting. Soluble deposits can usually be removed during overhaul by subjecting nozzles and buckets to a strong jet of water and compressed air. Some soluble deposits can be removed by various washing methods without disassembling the turbine

*"Indexes That Point to Turbine Overhaul" by E. E. Harris and G. B. Warren, Turbine Engineering Department, General Electric Company, Schenectady, N. Y. Electrical World, October 31, 1942.

**"Maintenance Can Prevent Steam Turbine Accidents" by T. W. Howard, General Electric Company, Power Plant Engineering, October, 1942.

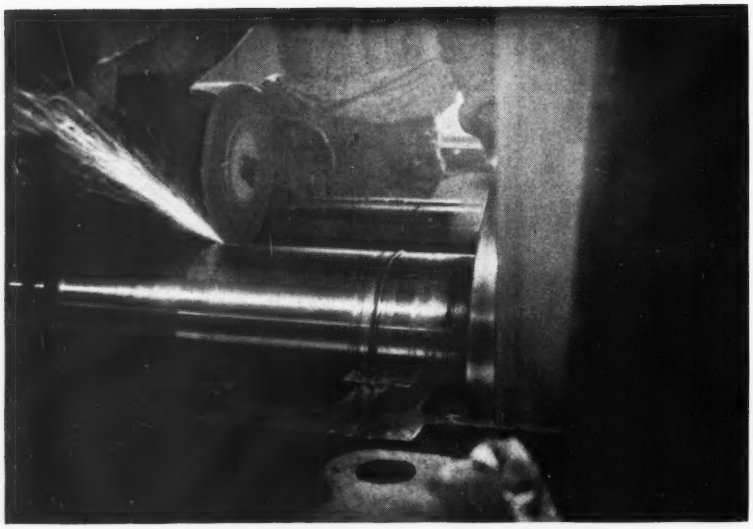


Fig. 2. Grinding a main journal

of steam-path parts by the use of sand blast is not recommended as this method produces rough surfaces which increase steam consumption. Sand blasting produces sharp edges from which cracks may start and there is always the danger of cutting away valuable metal in an attempt to remove hard deposits. Cleaning with a fly ash blast or hand scraping is preferable to the use of sand blast. (Fig. 1.) The time spent in carefully looking over steam-path parts for defects is well worth while.

Wheels, Rotors and Shafts

The rotating parts of a steam turbine are relatively highly stressed at speed. Therefore, it is important that these parts be cleaned down to bare metal and made as smooth as the original surface so that any defects, such as cracks, will be disclosed. Tests for cracks should be made by the "kerosene whiting" method or by the magnetic test if suitable equipment is available. Wheels should be checked for movement on the shaft, cracks at the keyway, and sharp edges at the equalizer holes. The sound of each wheel when tapped with a hammer should be noted. A dead-sounding wheel is not necessarily a defective one, but a careful investigation should be made of any wheel having a dead sound if it previously had a bell clear sound when tapped with a hammer as such a change indicates a change in the solidity of the rotor assembly. Loose or cracked wheels often sound dead. Should welding be attempted on any rotating parts of a turbine, the manufacturer should first be consulted. Welding, improperly done, can set up internal stresses and also change the structure of the metal and cause cracks which may progress to failure.

Rough or pitted journals should be stoned, ground, or turned, depending upon the extent of the surface damage. If a suitable lathe is not available this work can be done with the rotor in the unit. The photograph (Fig. 2) shows a No. 2 journal being ground with the rotor in place, using temporary bearings at the oil deflector fits and driving the rotor by means of a motor belt drive on the shaft coupling. Figure 3 shows the set-up for grinding a No. 1 bearing journal. If it is found necessary to true up a coupling face, great care should be taken in preparing the set-up for doing this work. The rotor should be blocked so that it cannot move axially. To check the coupling face after machining or grinding, place an indicator at a point directly opposite the point where the cutting tool is mounted. If the indicator is placed in the tool post where the cut is taken it will usually indicate zero under any condition, whereas if the indicator is mounted directly opposite the tool post, it will indicate a runout double the actual runout if there was any axial movement of the rotor during the machining. This check should be made on all coupling faces being faced either with the rotor in its bearings or with the rotor in a lathe. Very often coupling faces are improperly machined in a lathe on account of the lathe spindle thrust running out, which causes a slight axial movement of the rotor. Coupling faces should be machined flat to 0.001 inch concave. Coupling faces must not be convex if good operation is expected.

Bearing Linings

The inspection and repair of bearings needs no comment as this is a well known procedure. The limited use of tin now makes it necessary to use lead-base babbitt for the bearing metal. Tests and experience indicates that lead-base babbitt metal will satisfactorily meet normal conditions. Oil leakage can often be reduced by using a good oil-resistant sealing compound at the fit between the oil deflector and the bearing housing. Bearing linings are usually manufactured with a vertical clearance over the shaft of 1.3 mils per inch of shaft diameter. If the rotor is in good balance with no tendency to vibrate, rebabbitting is not necessary until the vertical clearance has become 2.5 mils per inch of shaft diameter. Records of past performance will usually indicate the allowable bearing clearance. A general statement as to the allowable bearing clearance cannot be made as this clearance varies with the type and size of the bearing.

Shaft Packing

In these days of scarce materials, careful consideration should be given to the reconditioning of old packing. By careful machining, worn packing can often be satisfactorily reconditioned. Shaft packing clearances recommended by the manufacturer should be maintained, otherwise vibration trouble may be encountered. If shaft packing fits are found to be pitted or eroded, the surface can be reconditioned by turning or grinding and refitting of the packing. Where metal spray equipment is available the shaft packing fits can sometimes be satisfactorily repaired, thereby maintaining the original shaft diameter at the packing bore.

Casing Erosion

Where casing erosion is experienced, the stage drainage should be improved if possible. Where the casing is steel, repair can be made by welding up the eroded portion. On a cast iron casing it is usually necessary to machine down the surface and install

patch plates to repair steam joints. Erosion elsewhere can be restored with metal spray of a non-corrosive material or by covering the worn spot with patch plates so that future wear will be on the plate which is replaceable. In all cases of serious erosion or corrosion it is advisable to determine the casing thickness by making a template of the contour which can be checked against the drawing dimensions by the manufacturer.

Lubrication System

Cleaning of the lubrication system is an important item in the overhaul work. It is a hard, tedious task to clean an oil system properly but it is worth while. A clean lubrication system results in longer oil life, reduces sludge, and helps prevent corrosion or rusting of parts. If any part of the lubrication system requires painting, be sure the proper paint is used. And, equally important, the surface must be properly prepared or the paint may come off with disastrous results. Consult your oil supplier for information on cleaning solvents and painting of lubrication systems. A partly cleaned system is a hazard as sludge or dirt from the dirty section may be dislodged and block lubrication.

Accessories

Many outages have been caused due to the failure of accessories, such as auxiliary oil pumps, pump regulators, throttle valves, exciters, relief valves, non-return valves, oil coolers, or air coolers. Don't forget to inspect the accessories, particularly the protective devices. All protective devices should be given an operation test before being placed in service and a record made of the test. Fatal accidents have occurred because of inoperative safety devices. Don't take a chance. Don't operate a unit having inadequate or inoperative protective devices.

Generators

There is a general tendency to pay little attention to the generator during overhauls, probably because of the difficulty in determining its deterioration, but when failure occurs it happens in a flash with a flash. If the effect of temperature on insulation life was realized, no doubt more attention would be given to the cleaning of generator coils and air passages. Dirty windings and dirt-plugged air passages increase coil temperatures and result in the reduction of insulation life. The failure of a generator stator or the field coils usually result in a long outage. A good job of inspection and cleaning cannot be accomplished without removing the field. When removed, the field should be given a visual check for loose fits on centering rings, retaining rings, wedges, and collectors. A careful check for cracks should be made on retaining rings, fan blades, and fan rings. On laminated fields, circulating currents caused by unbalanced phase operation flow through the coil slot wedges to the retaining rings, and intense heating or arcing may result at the contact points between the wedges and the rings. This heating or arcing changes the structure of the metal, reducing its strength, and fatigue cracks result. Retaining rings having burned spots or cracks should be replaced before the unit is again placed in operation.

Check the insulation resistance of armature winding and field winding. It is a good idea to do this every few weeks when the machine is shut down, keeping a record of the readings obtained, the date, and if possible the temperature of the windings.[1] When the field has reached room temperature the cold resistance of the windings should be measured and compared with the factory test measurements, after making any necessary corrections for temperature difference. If you are unable to check the factory measurement, send your reading to the manufacturer's district office and ask for recommended procedure.

A vacuum cleaner is very useful for cleaning the armature and field, but brushes are also required to dislodge the dirt. After a thorough cleaning, carefully inspect the air ducts to see that there are no obstructions. See that the wedges are properly in place and that the spacing blocks and cord ties on the end windings are in good condition. If the machine has been in operation for some time it may need a varnish treatment. Suitable varnish can be obtained from the manufacturer. The inside of the stator and the end windings should be sprayed or given a brush coat of this varnish, making sure to cover all exposed surfaces of coils, wedges, and spacing blocks.

Conclusions

Under present conditions, we are all inclined to "keep them running" independent of their condition, and this policy often results in long outages. To reduce the outage time, study the operation records, make regular inspections, keep accurate deterioration records, plan the inspection carefully ahead of time, secure a competent inspector to supervise the work, and skilled mechanics to do it. Keep them running longer by proper inspection and maintenance. It takes kilowatts to kill the Japs.

[1]In keeping records of insulation resistance, the actual values, provided they are reasonably high, are of less importance than the relative variation in readings over a period of time. Any sudden change in insulation resistance should be investigated at once. Ed.

Fig. 3. Set up for reconditioning a No. 1 bearing journal by grinding without removing the rotor from the casing

Turbine Maintenance and Repair Work*

Two methods of repairing eroded interior of large steam turbine casings are described, one is solely mechanical, and the other by utilizing arc welding

By ROBERT N. TUCKER, Superintendent, Division of Electricity, City of Columbus, O.

BOTH OF THESE turbines, whose maintenance and repair work is discussed in this paper, served as prime movers to drive 3600 r.p.m. direct connected alternating current generators.

In the case of the first unit, herein designated as turbine "A", the stationary blading was removed and the interior of the casing was machined by using a boring bar, enlarging the grooves for the stationary blading and truing the casing surface opposite the moving blades. In order to restore the blade grooves and clearances, it was necessary to reline the casing with brass strips of various dimensions and shapes so that after this latter work had been completed the interior of the casing was restored to its original new condition in so far as dimensions are concerned. Upon completion of the above work, new stationary blading was installed and from a practical standpoint, the stationary parts were practically equivalent to the original condition when the unit was first manufactured.

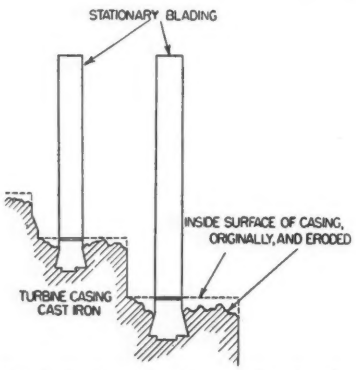


Fig. 1. Section through a portion of casing of turbine "A" showing its original interior surface line and the general effect of the erosion thereon

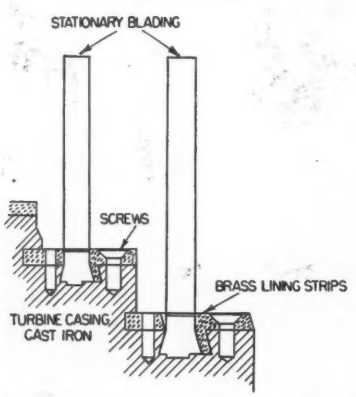


Fig. 2. Section through a portion of casing of turbine "A". Interior surfaces of casing and blading grooves have been machined by boring bar brass liners have been installed and fastened with screws; new blading is in place

In the case of the second unit, herein desigated as turbine "B", the repair work required was exactly the same as for turbine "A", namely, remove the stationary blading and then restore the blade grooves and casing interior to its original condition. In this instance, however, no machine work was required, for, after removing the stationary blading, the eroded ridges between the blading grooves were built up by electric arc welding to a point slightly in excess and, following the completion of the welding work, these ridges were then ground down by means of a special but simple radial grinding machine. Thus the grooving as well as the ridges between the grooves were returned to their original condition and proper radial clearance for the moving blades were re-established.

The difference in procedure for the two methods was noticeably outstanding because in the case of turbine "A" considerable time was required to perform the various machining operations, as well as to install the numerous pieces of brass liner and securing them to the cast-iron casing. Furthermore, four to five men were required to do the work. In the case of turbine "B", two men, including the welder, were sufficient to perform the work, which was accomplished in considerably less time, no machine work was required and the welded-on lining is a homogenous part of the casing. A tabulation comparing the more important items follows.

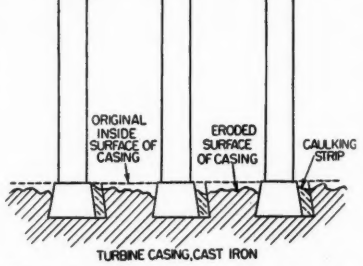


Fig. 3. Section through a portion of casing of turbine "B" showing its original interior surface line and the general effect of the erosion thereon

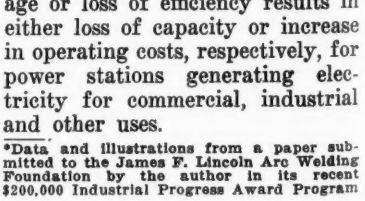


Fig. 4. Section through a portion of casing of turbine "B" showing various steps in the repair procedure

Factors Influencing Repair Work

Several items pertaining to this repair work deserve special mention. In the first place, it is evident that a steam turbine serving as a prime mover is a very costly piece of equipment and any service outage or loss of efficiency results in either loss of capacity or increase in operating costs, respectively, for power stations generating electricity for commercial, industrial and other uses.

*Data and illustrations from a paper submitted to the James F. Lincoln Arc Welding Foundation by the author in its recent $200,000 Industrial Progress Award Program

Furthermore, in event that the interior of a casing could not be properly repaired, the useful service life of these prime movers would be terminated and further utilization could be obtained only by replacing at least the casing and other stationary parts, or perhaps, a complete new unit would be required.

The first result of the casing erosion, opposite the moving blades, is to increase the clearance at the blade tips thereby reducing the efficiency of the prime mover. As the erosion progresses the stationary blading becomes loosened and continued operation would eventually cause stripping of the blading and possibly complete wrecking of the machine.

Engineers are well acquainted with the cost of this type of equipment and therefore a practical means of restoring the interior of a turbine casing to a condition equivalent to the original means a definite saving to the owner, and furthermore, the useful service life of the prime mover is considerably extended.

In so far as the turbine casings are concerned, the useful service life of the two prime movers, which were repaired, as described in this paper, has been extended by 10 to 15 yr. and if needed there is no reason why the repair procedure could not be repeated.

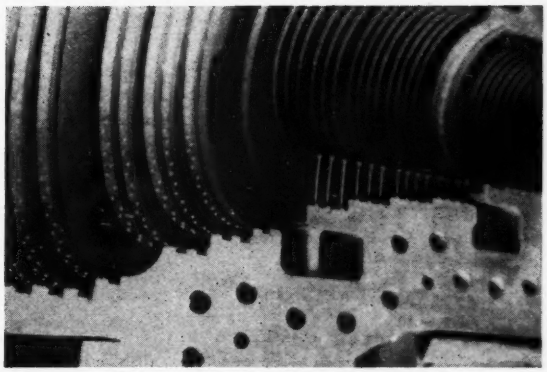


Fig. 5. Inside of casing of turbine "B". The last of nine rows of blading has been removed; the rough eroded portion of the ridges has been chipped off; ⅛ in. holes have been drilled in the ridges and anchor screws driven therein, the heads of the latter appear as white dots

Fig. 6. Inside of casing of turbine "B". About 50 per cent of the welding is done. Visible in the picture are: anchor screw heads (white dots) on ridges not yet welded; copper bulwark strips and holding clips; the rough surface of welded ridges; and the craters at ends of welding

General Description

As the flow of steam progresses through a turbine from the entrance nozzles to the exhaust it attains a condition at a variable point, usually near the exhaust end or a few stages therefrom, where, as a result of physical characteristic laws, moisture is formed in the expanding steam. The tiny droplets of water thus formed are impinged against the moving parts of the turbine spindle and part of them are then hurled at terrific velocity against the interior of the turbine casing. Since the moisture content of the steam may be approximately 10 per cent by weight, this combined with the high rotating speed, usually 3600 r.p.m., it is easy to visualize the fact that the tiny droplets of water hurled from the moving blades can cause considerable erosion of the interior surface of the casing when a unit has been operated for a number of years.

This loss of metal on the interior of the casing has two very detrimental effects; (1) it increases the clearance between the tip of the moving blades and the casing wall, enabling the steam to by-pass the blades at this point, thus reducing the engine efficiency of the turbine; (2) continued erosion assisted by corrosion, eventually removes so much of the casing metal adjacent to the stationary blading that the latter may become loosened. If this should happen and the stationary blading falls out of place, a more or less disastrous wreck usually takes place. The minimum consequence that can be expected would be the loss of one or more rows of blading.

The form of this erosion is typical and is shown in Fig. 1. It should be noted that the erosion is not uniform circumferentially,

Tabulation of Comparative Data

(Note: Whereas turbine "A" is 50 per cent larger than turbine "B", the costs, repair time, etc., for turbine "A" have been reduced by 33⅓ per cent in this report to obtain a fair comparison.)

Item No.		"A"	"B"
1	Turbine designation	"A"	"B"
2	Repair procedure	Mechanical only	Welding and Mechanical
3	Materials required	Brass liners, screws, turbine blading	Anchor screws and weld metal
4	Equipment required	Large boring bar	Welding machine and grinder
5	Men required to operate above equipment	3 to 4	1 to 3
6	New stationary blading required for repaired stages	all	none
7	Mechanic for boring bar	133 hr.; $387	.....
8	Welder	.....	40 hr.; $153
9	Material costs	$4310*	$118
10	Labor and pertinent costs	2420	452
11	Total	$6730	$570
12	Total man hours	1030	268
13	Days to repair casing and install blading	42	19
14	Estimated cost of replacing prime mover if repairs could not have been made	$120,000	$120,000

*Estimate $3600.00 of this amount is due to new blading.

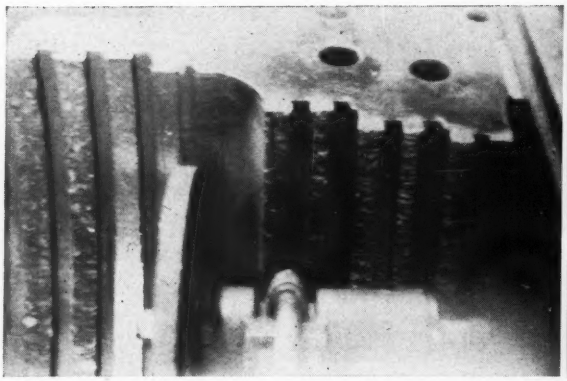


Fig. 7. Inside of casing of turbine "B". The welding is finished. Grinding of two ridges has begun; others are still in the rough state as left by the welder

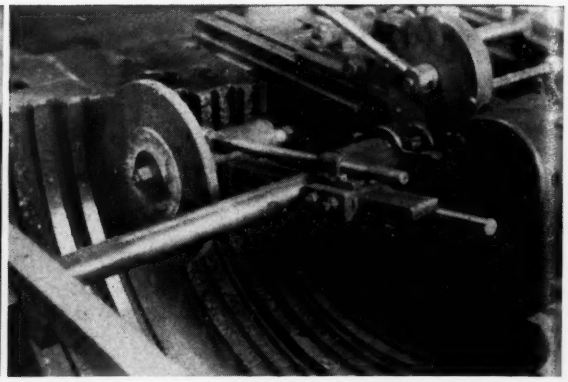


Fig. 8. Turbine "B". View of grinding wheel and rig. The main shaft is on the turbine and casing center line. Movement of lever in top right center causes wheel arm to swing in an arc with adjustable radius

neither is it always worse at the bottom of the casing, as might be the general impression; in fact, the most severe instance for the two units involved in this paper was at the top of the casing of turbine "A" and here the erosion adjacent to the stationary blading was so pronounced that several small sections of this blading had become loosened sufficiently to be moved in an axial direction.

Various methods of repairing the casing on turbine "A" were discussed with the manufacturer thereof, including the possibility of restoring or building up the casing interior by electric arc welding. This company's final recommendation was to remove the existing stationary blading; use a boring bar positioned on the spindle center line to remove the eroded portions of the casing and bore out the interior to an enlarged diameter. The grooves for the stationary blading were likewise enlarged in an axial direction. This was the general procedure and variations were made as required for each particular row of blading.

Following the completion of the machine work, brass liner strips of various cross sections were installed in the sides of the grooves and on the interior surface of the casing, the purpose being to restore the grooves and the casing interior to their original dimensions. The brass liners were secured by insertions and countersunk machine screws, the heads of which were later silver soldered. A slight amount of finishing work was necessary on the surface of the brass liners and then new stationary blading was installed.

A typical section through a portion of the casing is shown in Fig. 2, illustrating the finished work for turbine "A".

In the case of turbine "B" the damage done by erosion was practically identical to that which occurred in turbine "A" although no blading in turbine "B" had become loosened.

The drawing shown in Fig. 3 is typical of the erosion which took place in turbine "B," this erosion being quite pronounced at some points but no blading had yet become loosened.

Various methods of repairing turbine "B" were discussed with the manufacturer the same as for turbine "A", but in the case of this turbine "B" the manufacturer favorably considered welding as a means of repairing the machine. The procedure followed was:

(1) The calking strips were removed to loosen the stationary blading.

(2) The existing stationary blading was removed intact, undamaged, and laid aside for reuse.

(3) An ordinary compressed air operated small chipping hammer and chisel was used to trim off the rough portion of the ridges between the grooves, obtaining thereby a new metal surface.

(4) A staggered arrangement of 1/8 in. diameter holes spaced at

Fig. 9. Turbine "B". Casing repair is finished and last nine rows of stationary blading are re-installed

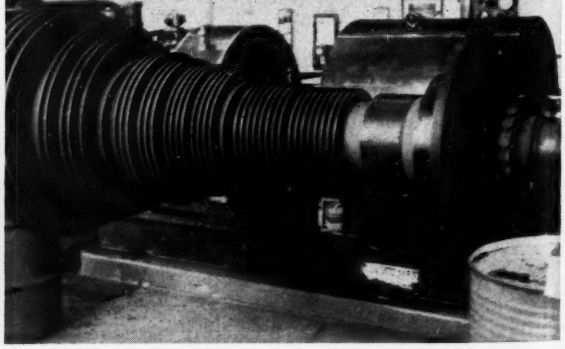


Fig. 10. Spindle of turbine "B". The last nine rows of the moving blades (left side) operate between the stationary blading rows where the casing was repaired. Spindle rotates at 3600 r.p.m. when in service. Close clearances require accurate workmanship

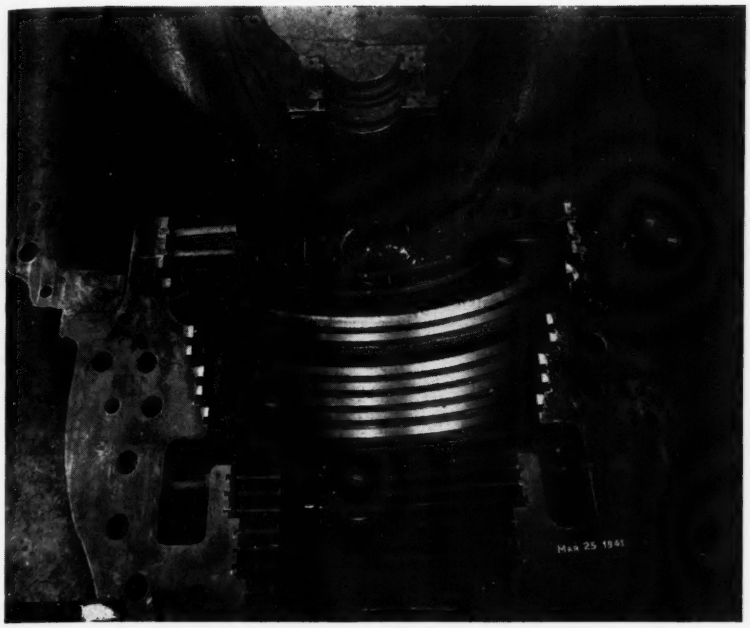


Fig. 11. Turbine "B". Enlarged view of top half of casing. Welding and grinding are finished. The last two rows of stationary blading are in place, and seven more rows are ready for installation. Note appearance of grooves and surfaces of ridges

approximately 1¼ in. were drilled along the ridges and steel screws were driven into these holes to provide additional anchorage.

(5) Heavy copper bars machined to the proper shape were placed in adjacent grooves to form a bulwark on each side of the ridge during the welding operation.

(6) The ridges were then built up by electric arc welding, using a $\frac{3}{16}$-in. electrode of cast iron and nickel composition. The welding current used varied from 300 to 350 amp. This welding was done very intermittently and at various points so as not to overheat locally any portion of the casing. The total amount of welding done at any continuous period did not exceed 2 in. of ridge length.

(7) After all of the ridges had been built up by the deposit of weld metal to a point slightly above the required finish line, an adjustable grinding wheel mounted on a radial swinging arm whose center of rotation corresponded to the turbine casing center was used to grind down the surplus deposit weld metal. This device was unique in its simplicity and, with one man operating it, the ridges were soon ground down to a finished surface corresponding with the original casing dimensions. Furthermore, the new surface is now more corrosion resistant as it is a nickel composition instead of the original cast iron.

(8) No machine work was required before reconditioning the grooves other than to clean them with a chisel point and wire brush to remove small foreign particles. The slight roughness on the sides of each groove was an advantage rather than an objection as it merely served better to hold the blading and calking in place. No trouble was experienced by weld metal adhering to the copper bulwark strips which were used over and over.

(9) Following the completion of the aforesaid, the original blading which had been removed was now re-installed, no new additional blading whatsoever being required, the ridges between the stationary blading rows having been restored to their original condition, the radial clearance of the moving blades was thus re-established to the original minimum, making the machine in this respect as good as the original new turbine.

The drawing in Fig. 4 shows sections illustrating the various steps in the repair work for turbine "B".

Various photographs pertaining to the work performed on turbine "B" are presented herein with an explanatory note pertaining to the essential features in each picture.

The pictures and drawings can convey only a part of the simplicity of the welding repair procedure as compared with the tedious boring bar machine work.

The value of this repair work is not in the pounds of weld metal deposited but rather is due to the fact that the welding process permits the restoration of a large expensive casing or machine to a condition as dependable and as serviceable as said part was when originally manufactured.

Dam Big Elevators

FOUR, HIGH SPEED, newest type elevators, have been installed in the Grand Coulee Dam and powerhouse, and are now in operation, reports the Bureau of Reclamation. Installation was made by the Otis Elevator Company, successful bidder for the contract.

One of the new lifts installed in the dam is the largest passenger elevator in the United States. It can easily carry thirty people, travels 500 ft. per min., the speed of an express, and drops 362 ft., the equivalent of a thirty-story building, into the heart of the massive concrete structure, giving access to the outlets of the 8½ miles of galleries or hallways inside the dam.

This machine can be geared to perform freight service as well. The platform of the car is 12 ft., 8 in. by 8 ft., 3 in., and when used to lift heavy equipment, has a capacity of 44,000 lb., and travels 100 ft. per min.

Two of the new elevators are performing service in the powerhouse, one for passengers, and one for freight duty. These machines average two thousand stops per day, being kept busy by the activity of workmen engaged in adding electrical generating machinery in the rapidly expanding powerhouse. One of these machines has motor-generator units identical to those used in the Empire State building in New York City. All of the elevators can be operated automatically, or manually, have electric-eyes in the doors, micro-leveling, trip and mileage recorders, and the latest safety devices.

It is expected that these elevators will offer a thrill to post-war visitors to the Grand Coulee Dam. A conducted tour is being planned for future tourists, giving them the opportunity to ride these swift machines, being taken deep into the dam, and permitting them to inspect the huge electrical generating equipment of the powerhouse, in actual operation.

Welding Butt Joints in Power Piping

By an ingenious method of preparation, a new type of butt joint is welded without the use of a backing ring. Details of this joint are described by the author who enumerates the objections to backing rings and gives conclusions drawn from tests performed on joints of the new type

By R.C. Fitzgerald, ***Consolidated Gas, Electric Light & Power Co. of Baltimore***

DESIGN of butt joints in power piping has been a matter of importance to power plant engineers and designers for some years. This is due to the special requirements of power piping as against the less stringent requirements of most other industrial piping installations. The problem in designing butt joints in power piping is to obtain a joint at least as strong as the pipe and, at the same time, one that is free, on the inside of the pipe, from protrusion or loose metallic particles.

Although the stresses in power piping are not excessive, installations are generally in service for from 20 to 30 yr. and may be subjected, to a considerable degree, to impact loads, as in the case of water hammer, or to fatigue conditions which can result from simple vibration. For this reason, it is desirable that butt joints approach continuity with the pipe as closely as possible, both internally and externally and, at the same time, develop the strength required by the pressure. A second important requisite of power piping, that is, internal cleanliness, is essential because of the damage that can be done to expensive turbine buckets and valve seats by small drops of weld metal carried into the turbine, or valve seats, by the passage of steam.

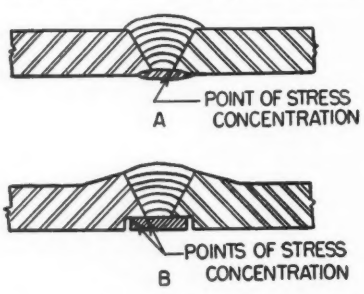


Fig. 1. Cross-sectional view of two popular recessed backing ring joint designs. (A) Tapered backing ring engaged in inside bevel. (B) Flat backing ring completely recessed in the pipe wall

In the early stages of oxy-acetylene welding of pipe, both the internal cleanliness of the pipe and the strength of the joint were variables. They varied directly with the following: (1) Joint preparation. (2) Welding technique. (3) Skill of the welding operator. These three things were, in themselves, variables and, aside from the joint preparation, were subject to little or no control. As a result, in the early days welded joints were apt to be either poorly fused in the root of the weld or excessively penetrated and full of "icicles" and free particles of metal on the inside of the pipe. Either of these conditions would make the joint undesirable from the standpoint of power piping.

To insure internal cleanliness and complete penetration to the root of the weld, various forms of "backing rings" were devised which were used as internal bridges between the butting pipe, the weld being deposited on this ring and filling the space between the pipe ends. With the development of successful, coated all-position electrodes for arc welding, the same general designs for butt joints were used with some changes in the backing rings, due to the different characteristics of the process.

Objections to Backing Rings

Although the backing ring effectively eliminates the hazard of foreign material in the pipe, there are some very valid objections to backing rings, both from a practical welding standpoint and from a more or less theoretical view. Some of these objections are as follows:

1. A backing ring that is thick enough to produce ample chill and, therefore, insures against "burning through" protrudes too far into the pipe and, to a certain degree, obstructs flow.

2. Recessed backing rings. Backing rings that are recessed into the pipe wall, either with a tapered fit or a straight counter bore, as in Fig. 1, have the disadvantage of removing part of the pipe wall. In the case of the tapered ring (Fig. 1 a), the pipe is beveled internally to the maximum allowable inside diameter of the pipe. This can mean that with the minimum allowable wall thickness, the ring would have little or no contact with the pipe, and the ring would be required to take all the heat of welding. This greatly increases the possibility of burn through and, at the same time, makes the joint very difficult to weld.

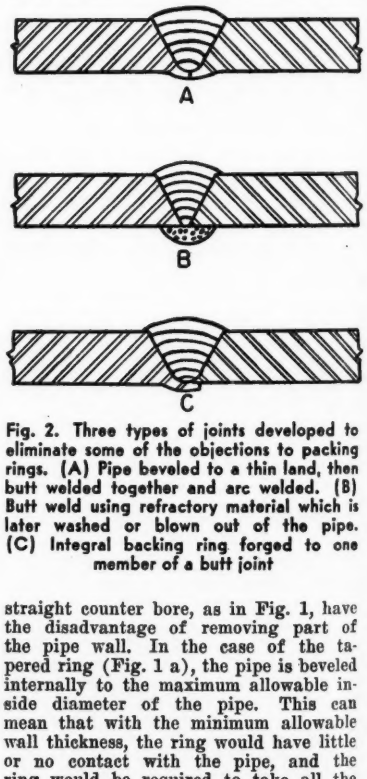


Fig. 2. Three types of joints developed to eliminate some of the objections to packing rings. (A) Pipe beveled to a thin land, then butt welded together and arc welded. (B) Butt weld using refractory material which is later washed or blown out of the pipe. (C) Integral backing ring forged to one member of a butt joint

Where the pipe wall is counter bored to receive a flat ring, as in Fig. 1 (b), it is necessary to upset the end of the pipe before machining the joint in order to maintain ample wall thickness through the weld. This increases the cost of the

joint materially, both in machining and welding.

3. Improper fusion of weld metal with the backing ring and the inside edge of the pipe (land of the pipe) causes "cold shuts" and incipient cracks at this point.

4. Tapered annular backing rings (Fig. 1 a) which are designed to engage an internal recess in the pipe tend to "upset" during welding and grow shorter on cooling, thereby pulling away from the pipe elsewhere and reducing the effective chill on part of the joint. This allows for arc blow, as mentioned in (2), and increases the possibility of burning through the backing ring.

5. Another practical objection to the use of backing rings, especially where the ring and pipe are machined for a

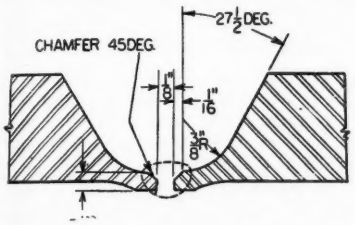


Fig. 3. Welding preparation for oxy-acetylene-metallic arc butt joint in pipe

snug fit, is the effect of comparatively slight misalinement on the weldability of the joint. This effect on weldability is the same as discussed in (2). In all field erection of pipe, it is necessary to adjust the piping to make up normal discrepancies in fabrication, especially with complicated shop fabricated bends and assemblies. Where the welding joint allows no tolerance for adjusting (massaging) the fit on field erection, placing the pipe on the job becomes a major problem and often necessitates heating and bending under difficult field conditions.

6. It is generally recognized that backing rings or "strips" in any welded joint are stress raisers or point of concentration of stresses (Fig. 1). How important these stress concentrators are on the inside of the pipe wall is not fully understood because fatigue tests on full size pipe are technically very difficult and tests on sections of pipe welds do not tell the whole story. However, at least theoretically the stress concentrations contributed by backing rings are not desirable and should be avoided, if possible.

Many types of joints have been invented with a view to overcoming the objections of backing rings welded into the pipe as a permanent part of the joint. Among these are designs for beveling the pipe to a thin land and arc welding the thin edges together. Another calls for the use of a temporary refractory backing ring which is washed or blown out of the piping system after the welds are made. A third design machines or forges a backing ring on one side of a joint and engages this ring with the other pipe. These designs (Fig. 2) have their unique advantages and disadvantages and probably any one might be acceptable for a given set of conditions.

New Type Joint Developed

The type of joint described hereinafter was developed with the same things in mind as were other departures from accepted backing ring designs; that is, to get away from the inherent disadvantages of backing rings and, at the same time, to produce a butt weld that was free from protrusion and had a high degree of continuity. Instead of approaching the problem from the angle of inventing something to replace the backing ring, it was undertaken with a view of employing well-known characteristics of welding processes and methods to the particular problem of joining pipe.

To begin with, the root bead that joins the two pieces of pipe together is the critical part of the weld. After the first bead has been made satisfactorily, the remainder of the butt weld can be easily made by following any good welding procedure. For this reason, when the root bead problem is solved, the joint design is accomplished. It was decided that if it were possible to obtain complete control over the molten metal in a welding bead by any method of welding, then that method of welding could be used in the root of the weld to join the pipe together. Because of the ease of control of a small bead with the oxy-acetylene process, this method was chosen in preference to other

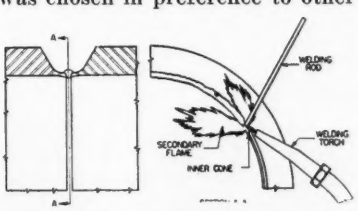


Fig. 4. Technique used for laying root bead

methods for welding the root of the pipe. After the root or sealing bead was deposited, the weld was to be completed by metallic arc welding so that essentially the pipe weld was an arc welded butt joint with the root sealed with a small oxy-acetylene weld.

The problem of design from this point was one of adjusting the characteristics of the joint in the root so that a small oxy-acetylene weld could easily be made, and, at the same time, arc welding could proceed from the root bead without danger of burning through. Dimensions of root spacing, angle

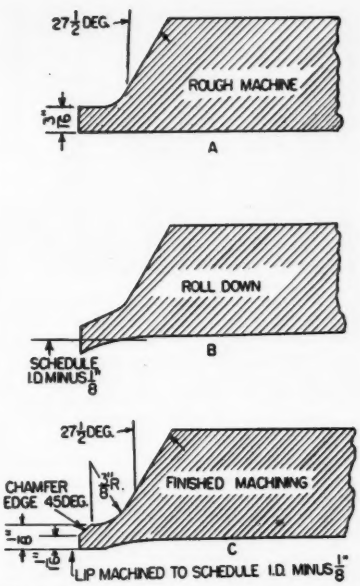


Fig. 5. Machining scheme for preparing joint for combination gas and arc welding

of bevel and radius of bevel were adjusted until a very satisfactory balance was reached. (See Fig. 3.)*

After an acceptable joint design was found, a number of test welds were made to determine the following:

1. Best Welding Procedure and Welding Materials for the Root Bead

It was found that the best control of the root bead was obtained by using the backhand welding technique and, in the case of horizontal butt joints, the direction should be from top to bottom of the pipe. A number of oxy-acetylene rods were tested, and it was found that any reliable grade of the so-called "High Tensile Strength" self fluxing rods were satisfactory. One-eighth inch diameter welding rods proved to be the easiest to handle. (See Fig. 4.)

2. Size of Welding Tip for Root Bead Weld

The size of the welding tip required to weld the root bead varies with the wall thickness of the pipe and the preheat employed. For pipe diameters up to 4 in. and wall thickness not exceeding ½ in., a number six tip can be used satisfactorily. Above this diameter and wall thickness a size seven or eight tip is better.

3. Nature of Welding Flame and Manipulation in Welding Root Bead

In welding the root bead it was found that a "soft" flame was more desirable than a "hard" flame; that is, for a given size of tip the lowest pressure settings for oxygen and acetylene that the tip will take without popping during welding, or flaring back into the mixer, gave the most desirable welding flame. Oxygen and acetylene were regulated to give a neutral flame.

By pointing the cone of the flame toward the bottom of the molten puddle in such a manner that part of the secondary flame passed into the inside of the pipe (using the backhand method of

*This joint design and welding procedure are covered by U. S. Patent No. 2288433.

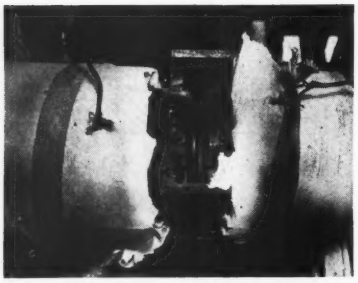


Fig. 6. Method of spacing and holding butting pipes in position before tack welding and before welding the first bead. After the tack welds are made, the bridges are knocked off when they interfere with the welding of the first bead. Resistance preheating coils are in place on either side of the joint

welding), the inside surface of the small bead being formed was substantially free from cupping or "piping" that generally occurs when molten metal freezes. (See Fig. 4.)

Lateral manipulation of the welding flame is necessary only in so far as it is necessary to supply extra heat to break down the thin edge or land of the pipe.

4. Degree of Welding Skill Required to Perform the Root-Bead Weld

Three electric welding operators were chosen who had had no previous experience or instruction in oxy-acetylene welding. These operators were given from 4 to 6 hr. instruction and practice in handling the welding torch. After this short practice time on the technique of welding the root bead, these operators were required to make test welds in 8-in. Schedule 160 pipe. The welds were tested and proved to be satisfactory in every way. Although these test welds were satisfactory, it is not to be construed that the operators were competent oxy-acetylene welding operators after such a short period of instruction. On the contrary, none of these operators could even begin to make a satisfactory "gas" weld in any other type of joint. The purpose of these tests was to determine how difficult it would be to train operators to perform this specialized weld, and they served to demonstrate that the weld requires no special ability. An experienced gas welder can make the weld with only a few instructions as to what is required and how to go about it.

5. Effect of Joint Misalinement

Butt joints were welded with the view of determining how much variation, both angular and lateral, could be allowed in field erection. The proper root spacing of ⅛ in. (See Fig. 3) is maintained by inserting the end of a ⅛-in. diam. welding rod prior to tack welding the joint. It was found that this space could be varied plus or minus $\frac{1}{16}$ in. without materially increasing the difficulty of making the root weld. This means that angular displacement at the welded joint can be as great as ⅛ in. per lineal foot of pipe in 12 in. diam. pipe without affecting the weldability of the joint. When this condition is encountered in field erection, the close side of the joint is, of course, welded first.

Where pipe joints are displaced laterally; that is, where the center lines of joining pipes are parallel but displaced one from the other, it was found that displacement of more than $\frac{1}{32}$ in. increased the difficulty of securing uniform penetration of both pipe lands. The tendency is to overpenetrate the nearer land and underpenetrate the far land. However, in field erection it has occasionally been necessary to weld joints with lateral displacement over $\frac{1}{16}$ in. and these joints have demonstrated that even this much displacement can be overcome without harmful effects, if care is exercised during welding.

After development tests were completed, a process qualification test was made in accordance with the provisions of the A.S.M.E. Power Boiler Code. This test was completed, and the joint was accepted for Code applications on the basis that the design and method of welding insured complete penetration through the root of the weld.

Following the process qualification test, it was necessary first to qualify a number of welding operators to perform the welding in the piping installation for a topping unit with 65,000 kw. total steam generating capacity. It was decided at this time to qualify only a limited number of operators to perform the gas bead in the root of the weld for two reasons: (1) The welding of the root bead took such a short time (20 to 30 min. on 12-in. pipe) in comparison with the time required to complete the joint by metallic arc welding. (2) Reduce duplication of welding equipment.

Welding operators who had some gas welding experience were selected and qualified on the root bead weld as well as the arc weld. Other operators were qualified on the arc welding alone, the root bead of their work being welded by one of the "combination" operators. This system was found to work very well in both shop fabrication and field erection and at no time was the job held up for lack of an operator capable of welding the root bead.

At times a few of the "combination" operators developed a sort of "artistic temperament" due to a fancied specialists indispensability. These ideas were quickly dissipated by simply qualifying another operator who had no previous gas welding experience. Because of the bevel design, the arc welded portion of this joint is very easy to weld. No difficulty was experienced in qualifying welding operators for either the root bead or the arc weld.

Fabrication and Erection Experiences

In shop fabrication of piping assemblies one of the largest items of cost is that of fitting joints for welding. It was anticipated that this item of cost would be greater on joints without backing rings, but in shop fit-up work, it was found that proper joint fit-up along with maintenance of assembly dimensions was easier to obtain with this type of joint than with backing ring joints.

Machining the joint preparation is done in three steps, as illustrated in Fig. 5: first a rough cut is made which approximates the contour of the finished bevel. The next operation rolls the thin edge of the pipe inward by an amount that will allow a comfortable margin for finish machining inside and outside. The third operation is to finish machine the "J" groove on the outside and cut the inside diameter to that specified for the particular pipe.

The roll down has only one purpose, and that is to insure a uniform inside diameter for the pipe regardless of variation due

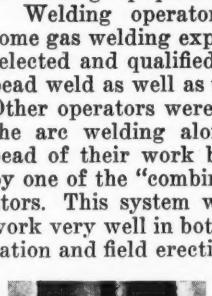


Fig. 7. Tack weld in an 8-in., Schedule 160 pipe joint. In pipe sizes up to 12 in., four such tacks are used to maintain alinement after the bridges are removed and while the root bead is being welded

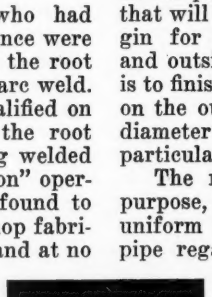


Fig. 8. Outside appearance of the gas bead welded in the root of the joint

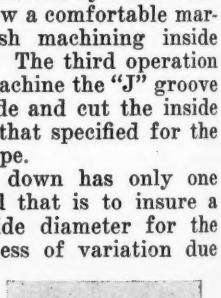


Fig. 9. Inside appearance of an average acetylene root weld. This joint was made in the horizontal-fixed position in 10-in., Schedule 160 C Moly pipe

Fig. 10. Making a root weld in a 20-in. standard pipe. The bridges have been removed where they interfere with the welding operation. Note the position of the torch relative to the weld

to mill tolerances. As specifications are now written, fairly large tolerance is allowed on wall thickness of pipe. Taking the maximum tolerance for both wall thickness and outside diameter together, the total, which is translated into variation in inside diameter, can be as much as 0.42 in. over the calculated nominal inside diameter. This variation is extreme, but it is permissible in 12-in. Schedule 160 pipe.

In the case of valves or fittings, where the inside is machined, the correct inside diameter can be specified and the roll down is unnecessary. In no case does the roll down affect the weldability of the joint. Producing this welding preparation is, without doubt, more costly than machining a simple bevel, but it is felt that the saving in fit-up time and the better weldability due to uniform inside diameters is worth the additional cost.

With pipe of larger diameter than 12 in.; that is, pipe measured by outside diameter, it was found that machining this welding preparation was easier than machining tapered backing rings and inside bevels for the joint design of Fig. 1a. This was due to the tendency of O.D. pipe to be out-of-round and also to the inherent difficulty of machining the thin tapered backing ring of large diameter. In the case of O.D. pipe, the combination gas-metallic arc joint is undoubtedly a cheaper preparation.

In field erection of piping, using the combination gas and arc weld, it was found that the fit tolerance, referred to above under "effect of joint misalinement," was a great help in speeding up the job. With joints requiring a better fit for proper weldability, it would have been necessary in a number of cases to heat and bend the pipe to suit conditions in the field or to correct small discrepancies in the fabricated assemblies. However, with this joint it was possible to adjust the location of the pipe and still have a fit-up that was entirely acceptable for gas welding the root bead. A relatively small number of such cases can make a considerable difference in the erection time for a piping system.

In the power piping installations for approximately 165,000 kw. electric generating capacity, the total number of combination gas-metallic arc welds used was in the neighborhood of 800. Another unit, now building, will increase the total of these joints to well over a thousand. These figures represent the use in only one power company. In addition, this joint has been used in two other installations in other power systems. In no case where this joint has been used has any difficulty been encountered either in fabrication and erection or afterward in the service of the pipe.

Prevent Fuel Waste for War[1]

By J. F. Barkley[2]

VARIOUS surveys have shown that combustion efficiency in the use of much of our coal output is too low and that effective effort would improve the use of at least 300,000,000 tons of coal per year 10 to 15 per cent. Fuel is one of the bulkiest items of transportation. The consumption of less fuel will relieve the mines as well as transportation facilities, an exceedingly important consideration at present. It is estimated that 25,000 coal miners working one year would be needed to mine the above indicated saving in coal, which would fill about 670,000 railroad cars.

Waste of fuel at this time gives definite help to our enemies, and all efforts should be made to prevent it. This country must conserve to the utmost its fuel resources—basic war power.

It is suggested to fuel users that the following recommendations be checked at their plants to determine to what extent they are being followed:

1. Preparation of Fuel — Keep the larger and smaller sizes of solid fuels well-mixed, if possible. Keep undesirable water out of the fuel

2. Equipment—Clean, oil, and repair fuel-burning equipment, and maintain all automatic equipment and controls in proper adjustment. Keep boiler-room instruments properly calibrated and in good working order.

3. Combustion—Use no more air than is necessary to prevent too much unburned fuel, including smoke, from going out the stack. Study the flaming of the fire and its color. Watch for dark smokiness. Note fuel bed conditions as to thickness, holes, caking, clinkering, and hot flying particles. Take the temperature of the flue gases, and watch the carbon dioxide if instruments are available. Prevent undesirable unburned fuel in the refuse; reburn siftings and fly ash high in carbon.

4. Drafts—Keep the draft or suction in the furnace and the wind-box pressure as low as possible. Maintain dampers and damper bearings in good condition.

5. Use of Boilers — Arrange number of boilers on the line to use the least fuel, avoiding sustained high overloads as much as possible.

6. Boilers—Stop all undesirable air leaks in the boiler setting around headers, doors, peepholes, shells, drums, and soot blowers. Keep all heat transfer surfaces clean on both sides. Keep furnace brickwork and baffles in good repair, with baffles free from soot and fly-ash piles.

7. Blowing Down—Blow down boilers as little as possible.

8. Leaks and Insulation—Keep equipment and piping free from steam and water leaks. Insulate all possible hot surfaces to lower heat losses.

NOTE: Devise fuel-saving schemes peculiar to your boiler plant, including possible changes in equipment.

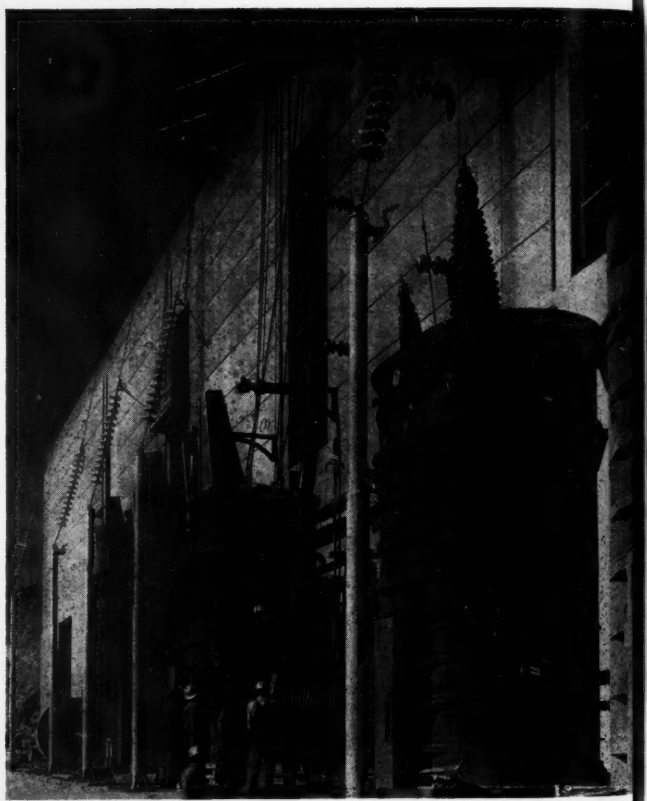
THE EXCELLENT results secured with the first large size, high-pressure, high-temperature forced-circulation boiler in this country point the way to further progress in this direction as soon as war restrictions permit.

[1] Published by permission of the Director, Bureau of Mines, U. S. Department of the Interior.

[2] Chief, Division of Solid Fuels Utilization for War, Bureau of Mines.

PICTURE

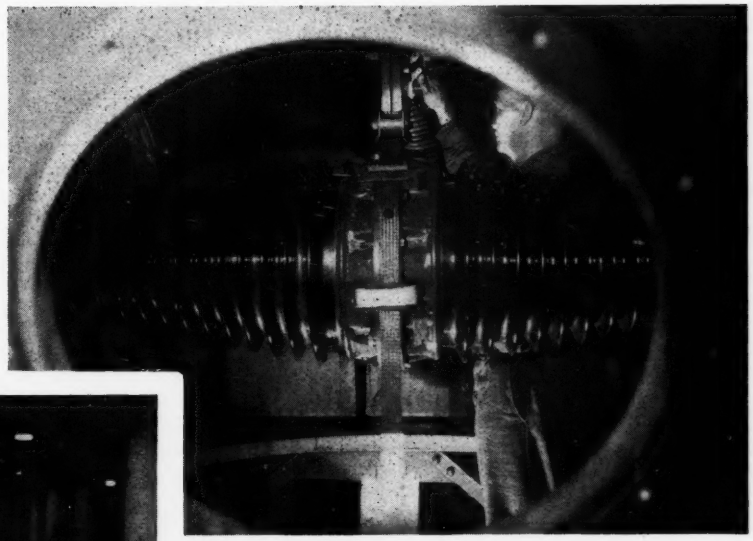
(Left) Man-made lightning streaks toward a model explosives plant but is warded off by the wire umbrella devised by Dr. Gilbert D. McCann, Westinghouse Elec. & Mfg. Co., engineer. This photo, taken at the Westinghouse high voltage laboratory at Trafford, Pa., shows the effectiveness of the new lightning protection system which already is guarding war industries. A wire strung from poles at each end of the building is connected to steel rods which are buried in the ground, thus guiding the lightning harmlessly into the ground



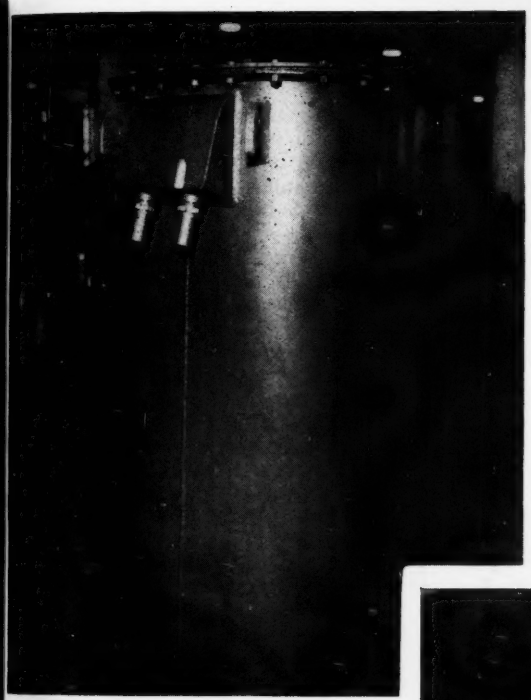
(Right) Transformers at Parker Dam power plant which began operation in December. Built by the Bureau of Reclamation, the dam located downstream from Boulder Dam is one of the series which controls the fractious Colorado River. The power plant was completed under the Department of Interior war program, to contribute a large block of power for the war industries of the Pacific Southwest

(Left) A 12-ft. planer which was exhibited at the World's Columbian Exposition at Chicago, in 1893 has been revitalized at one of General Electric's New England plants and is helping to turn out propulsion equipment for combat and cargo ships. The machine was rebuilt at a cost of $25,000 and is equal in performance to a new one, which, if it could be bought today, would cost $125,000. The illustration shows part of an outer casing for a turbine being machined

# of Engineering Interest



(Right) Setting a new high in size, this 132,000-v. disconnect switch is for one of six large power transformers built by General Electric for a west coast installation. The switch enclosed in its steel casing, weighs 11,000 lb. The casing holds 1660 gal. of oil, which makes the weight of the complete switch almost 12 tons. The photo was taken through one of the manholes



(Left) Representing a new departure in standard utility practice, the transformer case illustrated here was fabricated completely of genuine wrought iron, replacing steel heretofore used almost universally for such installations. According to officials of the large eastern utility company which ordered a number of them, the change was made in the belief that the new cases will have a longer life than ordinary cases

(Right) Most spectacular of the many interesting operations that go into the assembling of a giant Grand Coulee Dam generator is the placing of the rotor. Here a 450-ton wheel, part of one of the two 75,000-kw. Shasta Dam units, to be used at Grand Coulee for the duration to increase delivery of electrical energy to war plants, is being lowered into the stator, the stationary part of the generator. To prevent damaging either part, sticks are inserted between the stator coils and rotor magnets to check the clearance, which is only 5/8 in. The wheel is 25 ft. in diameter and 7 ft. high

A New Armature Winding Diagram

Part 1

It is not often that we are privileged to present an article as valuable or of such fundamental importance as this one on Armature Winding by Mr. Taylor. It should command greater interest from more industrial electrical engineers and operators than an article on any other single electrical subject. Rotating electrical machinery represents the beginning of all electrical generation and the end of most power utilization. Every engineer or operator in charge of such equipment is vitally interested in the electrical connection of the machines. Every such operator would like to have easily available a thoroughly reliable diagram of all the principal electrical machinery stator and armature windings. Such a diagram would constitute an ever ready reference and educational asset for the entire operating staff. It would show at a glance how winding connections can be made where burn-outs have occurred, what change-overs and re-connections are possible. All this information and much more is given by the system of diagrams devised by the author and described in this and subsequent articles. The polar diagram shown in this article is only for comparison.

By WILLIAM T. TAYLOR

AT THE OUTSET let us assume that the reader is not an armature winder—merely a person attending the operation and maintenance of electrical machinery. As a general rule it may be taken that operators would like to know such things as how to identify the coil throw, the number of coils per phase and per pole-phase group, number of phases and poles; whether the winding is full or fractional pitch, integral or fractional slot; how the electrically identical coil-side positions are found; where to locate the phase group and the phase-lead positions, and so on.

The form of base diagram presented herein visualizes all these conditions at a glance; moreover, this form of diagram is ideally suited to illustrate principles of winding elements such as the above mentioned as well as the systems of coil end connections—lap, wave, mush, basket, concentric, etc. The two latter types introduce invaded phase-belts which readily adapt themselves to this form of winding diagram though the invasion is distinctly different.

Using only the straight-line diagram let us take a 12-slot stator core and fit it with full-pitch 2 coil-side per slot (top and bottom) coils, and further let us assume Fig. 1 in the first instance where a 12-slot and coil, full-pitch *single-phase* 4-pole winding is to be made. Figure 1 shows that each coil and each phase-group spans a full pole pitch, i.e., the coil throw is from slot 1 to slot 4 inclusive, and each phase group is seen to have the same electrical angular degree span. We also see 3-slots and coils per pole and per phase, or 3 by 1 by 4 is 12-slots and coils in the whole winding; that the full-pitch is a pole span and covers 180 electrical angular degrees.

Using the same 12-slot stator core and the straight-line diagram for simplicity, let us now assume that a 12-slot and coil full-pitch *3-phase* 4-pole winding is to be made (see Fig. 2). In this case each coil spans a full-pitch which is from slot 1 to slot 4 as before, but there is now 1-slot and coil per pole per phase, or 1 by 3 by 4 is 12-slots and coils in the whole winding. We also see that each magnetic pole-span is split up into three

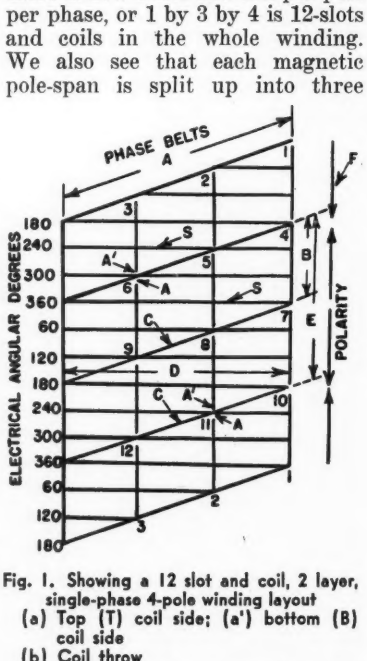


Fig. 1. Showing a 12 slot and coil, 2 layer, single-phase 4-pole winding layout
(a) Top (T) coil side; (a') bottom (B) coil side
(b) Coil throw
(c) Magnetic pole zone boundaries
(d) Phase zone
(e) Electrically identical positions
(f) Polarity of windings
(s) Slot

equal parts, that the phase groups are 60 electrical angular degrees apart and the coil span is 180 electrical angular degrees.

Now let us assume an 8-slot stator core fitted with 8-coils to give full-pitch and a *2-phase* 4-pole winding. In this case Fig. 3 shows that each magnetic pole span is split up into two equal parts, that the phase groups in each pole span are 90 electrical degrees apart and the coils span 180 electrical angular degrees as before.

An examination of these three base diagrams (Figs. 1, 2 and 3) shows that the following information is visualized:

(a) Top (T) and/or bottom (B) coil-side positions and their electrical angular degree values and relations; s = slot.

(b) Coil throw and the electrical angular degree value.

(c) Magnetic pole zones and the neutral or pole-zone-boundaries, basically set at the 180 electrical angular degree positions.

(d) Phase zones, phase boundaries and their electrical angular degree positions, values and relations.

(e) Electrically identical positions and their electrical angular degree values.

(f) Polarity and the direction of current flow through every coil side in the winding.

We thus see from this that the armature winding base-diagram is founded on fundamental principles of the rotating electrical machine—not imaginary mechanical layout common to the conventional and other armature winding diagrams.

For the single-phase winding

(Fig. 1) the electrically identical coil-sides are 1-7, 4-10, 2-8, 5-11, 3-9 and 6-12; for the 2-phase winding they are: phase A is 1-5 and 3-7, and phase B is 2-6 and 4-8; for the 3-phase winding they are: phase A is 1-7 and 4-10; phase B is 2-8 and 5-11; and phase C is 3-9 and 6-12.

Thus, before any of the coil end connections are known or drawn-in, we are able to visualize every electrically identical (also equi-potential) positions and their respective electrical angular degree relations and values. This also applies to fractional pitch as well as fractional slot windings which will be shown in a subsequent article; they also show that the fractional pitch modifies the magnetic pole zone in one direction whereas the fractional coil modifies the magnetic pole zone in a direction at right angles. This form of diagram also shows how the phase-zone coil connections of a lap-coil differs from that of a wave-coil winding.

One outstanding principle of this diagram is the coil-throw layout which define (for all practical purposes) the magnetic pole zone boundaries. Both forms of diagrams (the *polar* or the *straight line*) indicate that the depth increases with increase in number of slots and/or coils per phase group, also with decrease in the number of magnetic poles for a fixed number of slots and/or coils per phase group; the sine curve or polar diagram drawn to scale shows this to practically true value.

Figures 1, 2 and 3 are illustrative of the *first* stage only, and they are herein regarded as base diagrams for the simple reason that they show the principal basic winding elements. They do not show the system of coil end connections which involve the *second* stage and which cannot very well be classified as any part of the basic winding proper. Thus the first stage shows all that part of the winding subjected to electro-magnetic influence. Figures 1, 2 and 3 show that electrically identical and equi-potential positions occur on the same vertical line—the former may represent the brush positions for a direct current machine. There is no mistaking these positions because they lie on the same circle for the polar diagram and on the same vertical line for the straight-line diagram (see Figs. 2-2a). If they do not have identical electrical angular degree values then the connections require checking; a base diagram may therefore be regarded as a connection checker.

To those familiar with Taylor's "Transformer Practice", William T. Taylor needs no introduction. For many years this book was and still is a classic when it comes to explaining transformer windings and winding connections. First published in 1908 when the author was stationed in Kashmiri, India, this book has run through many editions and is today as valuable as the day it was first released. William Taylor has devoted practically his whole professional life to the electric power industry as manager or engineer in this country, various parts of Latin America, Africa, India and elsewhere. He is the inventor of the well-known TAYLOR 3-phase-2-phase system, also the inventor of the "A" electric power system which converts the "V" and the delta systems so that a true neutral grounding point is obtained. With this system the delta voltage increases without changing the phase angle, and both star and delta connections can be obtained on any or both sides of the system.

For a number of years Captain Taylor carried on a consulting engineering practice in England. He was bombed out of office soon after the outbreak of the present war, then joined the War Office as a temporary Garrison Engineer during the rush construction of barracks. He is a retired officer of the Royal Engineers (T.A.) having held the substantive rank of Captain since 1915. During the initial development of bases in the West Indies, leased to the United States, he was engaged with the U. S. Corps of Engineers.

He is a fellow A.I.E.E. and a M.I.E.E. As a member in good standing he resigned his associations as M. Am. Soc. C.E., and M. A.S.M.E. and M.I.Mech. E. For 25 yr. he has been a full member of the Institution of Civil Engineers of Great Britain. He is the author of several technical works, including "Transformer Practice" referred to above, published in this country and Great Britain. The armature winding diagrams presented in this and subsequent articles were copyrighted by him in 1936 as "unpublished matter."

For upward of 2 yr., Mr. Taylor has been an official of the United Kingdom & Canada Technical Mission in New York. In 1941 his home in the south of England was bombed, his wife killed and his 17 year old daughter rendered insane due to fright and shock. During the 1914-18 war in Europe he was a technical officer attached to the R.F.C. and then the R.A.F.

For fractional-pitch windings, i.e., windings with coil-span less or more than full-pitch or 180 electrical angular degrees, the pole-zone-boundary lines should be moved up or down one or more slots as the case may be; preferably, they should be drawn auxiliary to the full-pitch pole-zone-boundary lines and parallel thereto. This will be shown in Part II.

For fractional-coil (unequally grouped coil) windings, also for emergency operation with missing coils due to previous burn-out, the coils which are deleted (say from an integral-slot layout) are shown broken in place of bold solid lines. These missing coils are symmetrically arranged in the phases and poles so as to secure best balanced winding conditions.

It should now be apparent that these simple basic winding dia-

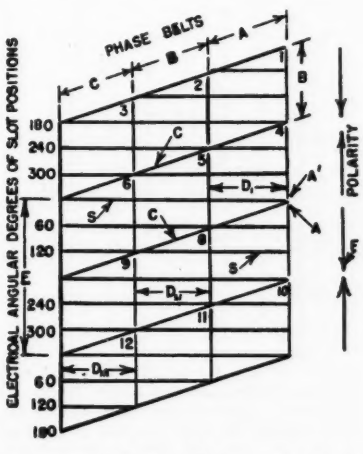


Fig. 2. Straight line diagram. 12-slot and coil, 2-layer, 3-phase, 4-pole winding layout

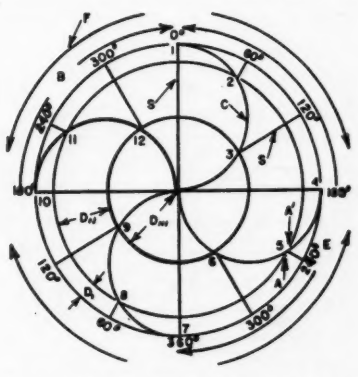


Fig. 2a. Polar diagram for the same winding as shown in Fig. 2

grams are all that is necessary to prove their utility, adaptability and scope of general usefulness; the straight-line diagram being the simpler of the two distinct forms.

As already indicated, the second stage in armature winding involves the system of coil end connections such as the lap or wave, etc. And here again we find that this form of diagram has the advantages because it provides simple, easy and regular symmetry of all the connections by straight lines with the fewest number of strokes which makes it free from misunderstandings or/and errors common to other winding diagrams; moreover, a pencil and straight-edge is all that is required to make a diagram of the most complicated 2-coil per slot unequally-grouped-coil or fractional-slot or fractional-pitch types; at a glance we visualize the positions, electrical angular degree, and number of active coils per phase per pole and per phase or pole for the former type, also visualize the positions and electrical angular degrees of coil sides and phases overlapped in the latter type of winding. All of which represent important information for those desiring to understand the practical fundamentals of armature winding.

It is obvious that a discussion of the types of windings (lap, wave, etc.) can serve no useful purpose until the reader knows the winding rule of each particular type. First, he must keep in mind that every armature coil has two ends which can be connected in one of two different ways. For alternating current phase windings the first rule is to connect the coil sides so that they follow (not oppose) the polarity, i.e., always keep in the direction of the arrowheads. Phase B of Fig. 4 is a whole unit, shown reversed but this does not change the rule.

For the common lap-coil (identical pole pair) connection shown in Fig. 4 the winding rule is: First, connect adjacent phase coils in single series to form a group; that is to say, the (B) or bottom coil-side or finishing lead of a coil is connected to the (T) top coil-side or starting lead of the coil adjacent to it, and the (B) bottom coil-side or finish of one coil group is connected to the start or (B) bottom coil-side of another group which is displaced by one pole pitch and under the next polarity, i.e., successive pole-phase groups are under the same pole-pair, but successive coil connections of a phase lie in the same polarity; whereas successive coil connections of a phase in a wave winding lie in different polarities. Then connect all the groups of a phase in series, which is a (B) bottom to (B) bottom connection followed by a (T) top to (T) top connection, and so on. All coil connections being completed first in each pole then each pole-pair before going to the next pole or pole-pair, respectively. The connections are the same for every pole pair and each phase winding. For a 3-phase winding, employing (T) top coil-side phase leads, one phase lead is in one polarity and the other two phase-leads are in the opposite polarity.

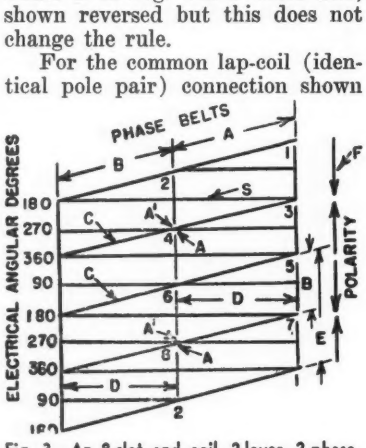


Fig. 3. An 8-slot and coil, 2-layer, 2-phase, 4-pole winding layout

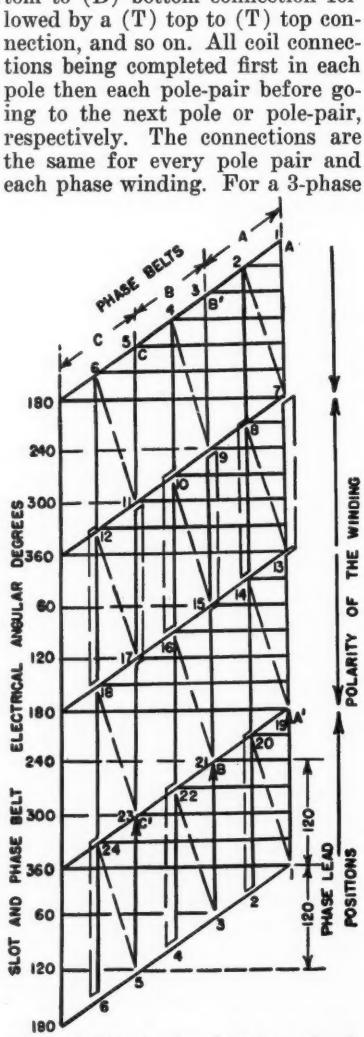


Fig. 4. A fully developed 24-slot and coil, 3-phase, 4-pole, lap-connected winding. Note that each phase winding is connected the same, but phase B has the line phase lead in slot 21, i.e., this winding is reversed. Phase B could start in slot 9 which would likewise be reversed

The common lap winding connection given in Fig. 4 shows a fully developed 24-slot and coil (2-layer) full-pitch 3-phase 4-pole winding layout. Taking phase C, the complete winding procedure is as follows: Starting in slot 5(T) and phase C zone, move vertically down to 11(B) then up to 6(T) and again down to 12(B) thus completing the first group of coils. Now move down from 12(B) to 18(B), then up to 12(T), again down to 17(B) and finally up to 11(T), thus completing the second group of coils. From slot 11(T) move down to 17(T) and repeat the same procedure for the second pole-pair, ending the phase winding as a (T) top coil-side in slot 23.

For the common wave-coil (identical polarity) connection the winding rule is: Connect coil ends to follow the arrowheads and the identical polarity which is a unidirectional one polarity single-series connection throughout each tour and section, i.e., follow a continuous series of (T) top to (B) bottom coil-side connections throughout one section, a (B) bottom to (B) bottom (reversal) section connection, then a continuous series of (B) bottom to (T) top coil-side connections throughout the other section. (Whereas the lap connection drops a slot per coil connection per phase group, the wave connection drops a slot, for a retrogressive winding, in every tour per phase.)

Successive coils are connected start to finish or the equivalent of a (B) bottom of one to the (T) top of another throughout a section, and the reverse procedure for the other section. All the coils in one section are in one polarity while all the coils in the other section are in the opposite polarity, i.e., all the tours of coils per phase winding are in identical polarity. Tour-to-tour and section-to-section are joined in a single series to form the complete winding. For each complete tour or round of coils all the connections are on the same vertical line (see Fig. 5) or the same circle for the polar diagram. And on the completion of a tour of coils a slot is "dropped" (see Fig. 5) for a retrogressive winding or an additional slot is "picked up" for a progressive winding.

A common wave winding connection is given in Fig. 5 which

shows a fully developed 24-slot and coil (2-layer) full-pitch 3-phase 4-pole retrogressive winding layout. Taking phase A, the complete winding procedure is as follows: Starting in slot 1 (T) and phase A zone, move vertically down to 7(B) which is the full pole-pitch and opposite coil-side, then move down to connect this coil end to the (T) top coil side in slot 13, again moving down to the (B) coil-side in slot 19 all of which (1, 7, 13 and 19) are in the same position in the magnetic field, have the same electrical angular degree (180) relations and consequently are on the same vertical line, thus proving easy identification and accuracy of connections. As this is the end of the first tour a slot is "dropped" so that the connection becomes 19(B) to 24(T). Again commencing at the top to complete the series, move down from 24(T) to 6(B) thence to 12(T) through this coil down to 18(B) which is the end of the first section. Up to this point only one-half of the coil-ends have been connected, and from this point the winding procedure is identically the same but in the opposite direction.

For a single-layer winding this would be the end of phase A. Starting the second section of the 2-layer winding as a bottom (B) in slot 18, move up to 12(B) thus completing the reverse connection. Again move upwards through this coil to 6(T) thence in the same direction to connect with coil end 24(B). At this point move to 24(B) at the extreme bottom end, thence move up to 19(T) which completes the first tour in the second section. By "dropping" a slot the second tour starts by connecting coil end 19(T) to coil end 13(B). Move up through this coil to 7(T), thence upwards to connect with coil end 1(B). Again move to the extreme bottom of this vertical line to 1(B) and then upwards through this coil to 19(T) which completes phase A winding. According to the above mentioned and Fig. 5 we see that each phase winding is connected the same except that the phase-lead positions are displaced 240 electrical angular degrees, whereas, in the lap winding, the phase leads are displaced 120 electrical angular degrees. We also see that a group coil-to-coil connection in the wave winding goes from pole-pair to pole-pair, whereas a group coil-to-coil connection in the lap winding is completed in one pole. Extracted from Fig. 5 the fully developed wave-winding table is:

	(← Tour →)				(← Tour →)				
	(T)	(B)	(T)	(B)	(T)	(B)	(T)	(B)	
A	1	7	13	19 ...	24	6	12	18	Reversing
A′	19	1	7	13 ...	18	24	6	12	connection
B	9	15	21	3 ...	8	14	20	2	Reversing
B′	3	9	15	21 ...	2	8	14	20	connection
C	17	23	5	11 ...	16	22	4	10	Reversing
C′	11	17	23	5 ...	10	16	22	4	connection
(← Section →)									

While the rules of lap and wave winding-connections do not affect the base diagrams shown herein, it is obvious that the reader must first know these rules before he can make any kind or type of armature winding diagram of conventional or any other form. In other words, the two rules referred to must be available in some way in order to make the fully developed winding connections no matter what form of diagram is used.

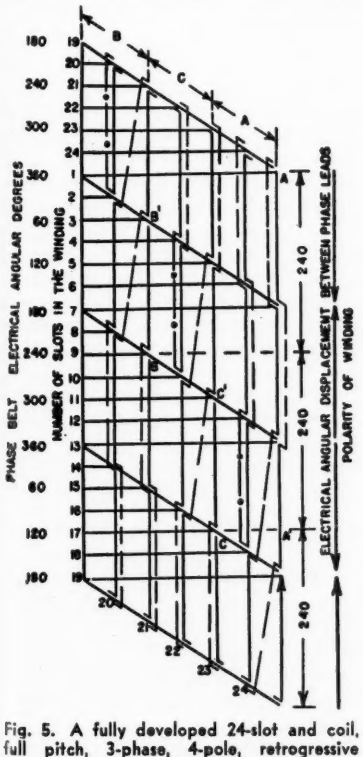


Fig. 5. A fully developed 24-slot and coil, full pitch, 3-phase, 4-pole, retrogressive WAVE winding

QUESTIONS

1. For Figs. 4 and 5, what is the slot spacing in electrical degrees?
Ans. Fig. 4 shows 30 deg., that is: $360/s(p/2) = 15$ deg. $\times$ $4/2 = 30$ deg.

2. (For Figs. 4 and 5) how many slots and coils are there per pole phase?
Ans. Figure 4 shows 2, that is $S/p\emptyset = 24/4 \times 3 = 2$.

3. (For Figs. 4 and 5) give the electrical angular degrees and the direction of current passing through those coil-sides within phase B field boundaries of the first magnetic pole.
Ans. Figure 4 shows 60 deg. to 120 deg., and the direction of current is clockwise.

4. Tabulate the coil layout and the order of coil grouping of Fig. 4.

	Poles	A	B	C	A	B	C	Coils per pole
Ans.	1	1–2	3–4	5–6	2	2	2	6
	2	7–8	9–10	11–12	2	2	2	6
	3	13–14	15–16	17–18	2	2	2	6
	4	19–20	21–22	23–24	2	2	2	6
				Per phase	8	8	8	24 total

A	B	C	A	B	C	A	B	C	A	B	C	
2	2	2	2	2	2	2	2	2	2	2	2	(coils per phase group)
No. 1			No. 2			No. 3			No. 4			(poles)

5. Extract the fully developed winding from Fig. 4.

	(T)	(B)	(T)	(B)	(B)	(T)	(B)	(T)	(T)	(B)	(T)	(B)	(B)	(T)	(B)	(T)	(phase overlap)
Ans. A	1		7–2		8–14		8–13		7–13		19–14		20– 2		20– 1	19	A′ none
B	21		3–22		4–22		16–21		15– 9		15–10		16–10		4– 9	3	B′ none
C	5		11–6		12–18		12–17		11–17		23–18		24– 6		24– 5	23	C′ none

6. In a lap winding do the number of groups per phase equal the number of magnetic pole in the winding? If so, why?
Ans. Yes. There are 12 groups in the 3-phase 4-pole winding, independent of the number of slots and coils, or, $12/3 = 4$ groups per phase for the 4-poles.

7. Can phase B winding be started in a different magnetic pole to that shown in Fig. 4?
Ans. Yes. Phase B may be started as a top conductor in slot 9 and ended as a top conductor in slot 3.

8. Can any two adjacent coils in a pole phase (phase group) be connected in parallel? If not, why?
Ans. No. Adjacent coils lie in different parts of the field and there is a difference of potential at the same instant of time. Fig. 4 shows that only those coil sides can be connected in parallel which lie on the same vertical line and have the same electrical angular degree value; thus, for phase A, 1 and 13 may be connected in parallel with 7 and 19.

Hydrogen Zeolite Treatment of California Water*

By Major S. P. Pickett, *Shell Oil Co., Wilmington, Cal.*

As an extension of the water treating system at the Shell Oil Co. refinery at Wilmington, Calif., a hydrogen zeolite softener was installed to supply a portion of the boiler make-up water, thereby releasing an equivalent volume of sodium zeolite soft water for the cooling system. The hydrogen zeolite process effects the simultaneous removal of hardness and alkalinity, accompanied by a reduction in mineral residue corresponding approximately to the amount of the original alkalinity, making it particularly advantageous for water supplies that predominate in either primary or secondary alkalinity. The measured benefit for the process after several months operation include: 115 per cent increase in boiler saline concentration, 63 per cent reduction in blowdown, 73 per cent reduction in boiler saline causticity, 44 per cent increase in boiler saline mineral residue, 75 to 80 per cent reduction in free CO_2 content of the steam and return condensate, and automatic establishment of the A.S.M.E. sulphate-alkalinity ratio for inhibition of caustic embrittlement. The maintenance of a minimum ratio of NaOH to SiO_2 in the boiler saline has been found necessary to prevent tube losses from silica deposits; in this case experience shows the minimum ratio appears to be about 0.6

CONTINUED refinery expansion with its accompanying increased requirement for soft water make-up for the boiler plant and cooling systems, demanded considerably more outturn than it was possible to obtain from the existing two sodium zeolite base exchange softeners at the Shell Oil Co. refinery at Wilmington, Calif. The situation was further aggravated with the replacement of a portion of the supply of about 4.5 gr. per gal. average hardness by water of 9.0 gr. per gal. hardness from a newly drilled well.

Immediately prior to the change in water supply, the sodium zeolite softener supplied the entire boiler make-up and had sufficient excess capacity to take care of 90 per cent of the cooling system demand, with 4.5 gr. per gal. raw water being used for the remainder. Since the hardness of the raw water had doubled, and the volume necessary to meet the shortage in the cooling system's requirements had quadrupled, additional softening capacity was required and was obtained by the installation of a hydrogen zeolite base exchange softener[1] to supply a portion of the boiler make-up, thereby releasing an equivalent volume of sodium zeolite soft water for the cooling system.

The hydrogen zeolite process effects the simultaneous removal of hardness and alkalinity, accompanied by a reduction in mineral residue corresponding approximately to the amount of the original alkalinity, making it particularly advantageous for water supplies that predominate in either primary or secondary alkalinity. The hydrogen zeolite mineral exchanges its hydrogen for the cations (calcium, magnesium, and sodium) in the effluent water. Regeneration is obtained by the use of sulfuric acid, similarly to the employment of sodium chloride in the case of sodium zeolite mineral. Regeneration of the hydrogen zeolite can also be effected with sodium chloride, but this procedure forfeits the advantages of alkalinity reduction which is in turn responsible for the other benefits.

The chemical reactions involved in the operations are as follows:

(a) Treatment

$$\text{Cation } (HCO_3)x + H_2Z = \text{Cation } Z + H_2CO_3$$
$$\text{Cation } (SO_4)x + H_2Z = \text{Cation } Z + H_2SO_4$$
$$\text{Cation } (Cl)x + H_2Z = \text{Cation } Z + 2HCl$$

(b) Regeneration

$$\text{Cation } Z + H_2SO_4 = H_2Z + \text{Cation } (SO_4)x$$

The conversion of primary and secondary alkalinity to carbonic acid and the subsequent removal of the carbon dioxide in degasifier equipment effects a proportional reduction in the mineral residue, while the conversion of primary and secondary salinity to sulfuric and hydrochloric acids produces an acid effluent which must be neutralized to a predetermined excess alkalinity to be suitable for boiler make-up purposes. Neutralization can be accomplished by mixing the hydrogen zeolite effluent with the proper amount of sodium zeolite effluent or, alternatively, by treatment with caustic soda which results in a CO_2-free steam supply.

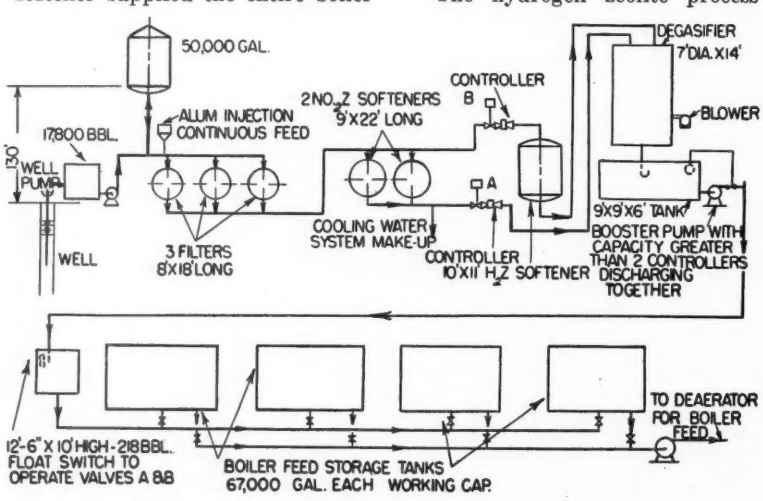


Fig. 1. Flow diagram of hydrogen zeolite water treatment system

Hydrogen Zeolite Equipment and Operation

The hydrogen zeolite installation consists of a vertical rubber-lined treating unit (10 ft. diameter by 11 ft. high) filled with mineral, together with a strong-acid lead-lined measuring tank (30 in. diam-

*Paper delivered at a West Coast meeting of the A.S.M.E.

[1]Zeo-Karb H, licensed under the patent of the Permutit Co.

eter by 30 in. high) and a dilute-acid lead-lined steel regenerating solution tank (84 in. diameter by 36 in. high). A degasifier (7 ft. diameter by 14 ft. high) is employed with a centrifugal air blower to remove the carbon dioxide and automatic control equipment is provided to maintain the desired ratio of hydrogen and sodium zeolite treated effluents. A flow diagram of the water treating system, after incorporation of a new unit, is given in Fig. 1.

Maximum capacity of the unit is 350 gal. per min. which is equivalent to capacity 320,000 gal. of treated effluent in a 15-hr. on-stream cycle, with a 1-hr. period allowed for regeneration.

The installation was placed in operation using a blend of 67 per cent hydrogen zeolite effluent and 33 per cent sodium zeolite effluent to give an alkalinity of about 15 p.p.m. as $CaCO_3$ in the resultant mixture. After 5½ wk. operation eight water wall tubes were burned out over a 15 day period as a result of silica deposits. In order to raise the NaOH content of the boiler salines by increasing the alkalinity of the mixture to about 35 p.p.m. as $CaCO_3$, the blend of treated effluent was changed to 58 per cent hydrogen zeolite and 42 per cent sodium zeolite. Subsequent operations have been free of tube troubles and no unusual difficulty was experienced in the operation of the equipment. The hardness and acidity of the acid effluent remained essentially constant throughout the treating cycle as shown in Table I. Chemical consumption is shown in Table II.

Quality of Treated Water and Boiler Salines

Based upon the analyses of raw, treated, and boiler waters, the following tabulation shows the effects of the hydrogen zeolite process from data given in Tables III and IV.

Volume sodium zeolite effluent in make-up	100%	42%
Volume of hydrogen zeolite effluent in make-up	0%	58%
Treated Water		
Mineral residue at 180 deg. C., p.p.m.	310	164
Alkalinity as Na_2CO_3, p.p.m.	198	37
Potential CO_2 content, p.p.m.	164	31
Sulfate-alkalinity embrittlement ratio	0.27	1.45
Boiler Water		
Mineral residue at 180 deg. C., p.p.m.	3,451	4,964
NaOH, p.p.m.	1,660	440
Na_2CO_3, p.p.m.	470	210
Alkalinity as Na_2CO_3, p.p.m.	2,667	790
Na_2SO_4, p.p.m.	829	1,777
SiO_2, p.p.m.	350	749
Sulfate-alkalinity embrittlement ratio	0.3	2.3
NaOH-SiO_2 ratio	4.7	0.6
Concentration factor	15.3	32.9

The improved quality of feedwater has permitted the concentration of the boiler water to be increased 115 per cent, with a simultaneous increase of 44 per cent in mineral residue, and a reduction of 73 per cent in causticity. Also, the sulfate-alkalinity embrittlement ratio has been increased to the A.S.M.E. recommendation for the boiler pressures in use (about 2:1).

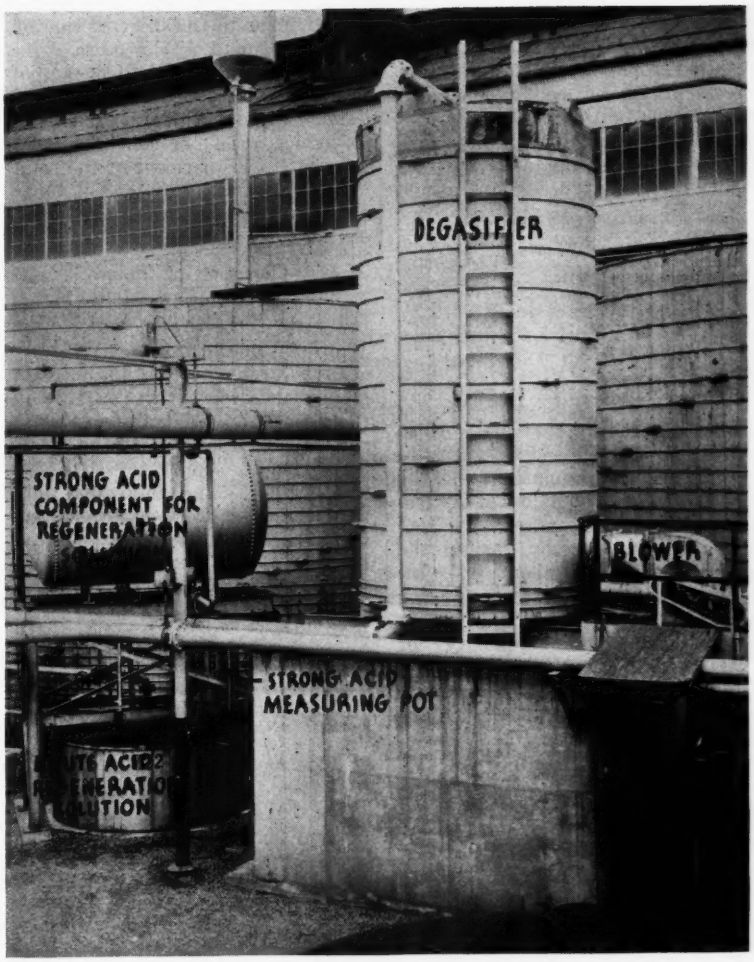


Fig. 2. View of water treatment equipment used in hydrogen zeolite system

Table I—Acidity and alkalinity during treating cycles

Treated Water: Quality as $CaCO_3$:	100% Sodium Zeolite Alkalinity	100% Hydrogen Zeolite Acidity	58% Hydrogen Zeolite 42% Sodium Zeolite Alkalinity
After regeneration and completion of rinsing, ppm.	186	85	29
After 2 hr. of hydrogen zeolite cycle, p.p.m.	186	70	35
After 4 hr. of hydrogen zeolite cycle, p.p.m.	186	72	38
After 6 hr. of hydrogen zeolite cycle, p.p.m.	186	73	36
After 8 hr. of hydrogen zeolite cycle, p.p.m.	186	74	36
After 10 hr. of hydrogen zeolite cycle, p.p.m.	186	73	35
After 12 hr. of hydrogen zeolite cycle, p.p.m.	Inoperative for short period while sodium zeolite unit being regenerated.		
After 14 hr. of hydrogen zeolite cycle, p.p.m.	186	73	33
After 16 hr. of hydrogen zeolite cycle, p.p.m.	186	71	33
After 18 hr. of hydrogen zeolite cycle and completion of cycle, p.p.m.	186	57	45
	Inoperative while hydrogen zeolite unit being regenerated.		
Average quality of outturn	186	72	35

Table II—Softener operations

Salt recovery system	Reconditioned Sodium Zeolite Units In Service	Reconditioned Sodium Zeolite Units Inoperative	New Hydrogen Zeolite Unit
Throughout per cycle, 1000 gal.	230	245	320
NaCl consumption per cycle, lb.	530	950	....
H_2SO_4 consumption per cycle, lb. 100 per cent	....	....	1012
Chemical usage, lb./1000 gal.	2.30	3.88	3.16
Chemical usage, lb./1000 cu. ft.	17.21	29.03	23.64

Tube failures after the introduction of the hydrogen zeolite process resulted from deposits containing in excess of 90 per cent silica. The high silica (SiO_2) content of the water supply, about 23 p.p.m., produced the following boiler salines under the three types of operation:

Volume sodium zeolite effluent in make-up	100%	42%
Volume hydrogen zeolite effluent in make-up	0%	58%
Mineral residue at 180 deg. C., p.p.m.	3,451	4,964
Silica as SiO_2, p.p.m.	350	749
NaOH, p.p.m.	1,660	440
Na_2CO_3, p.p.m.	470	210
Concentration factor	15.3	32.9
Ratio of NaOH to SiO_2	4.7	0.6
Ratio of alkalinity as $NaCO_3$ to SiO_2	7.6	1.1

On the theory that a low ratio of NaOH to SiO_2 during initial operation was responsible for the deposits, the proportion of hydrogen zeolite water was reduced from 2:1 to 1.4:1, thereby raising the ratio from 0.3 to about 0.7. Increasing the ratio sufficiently far toward 1.33, which would supply the stoichiometric quantity of NaOH for converting all SiO_2 to Na_2SiO_3, was expected to eliminate the silica deposits. Since establishment of the new ratio, boiler operations have been unimpeded by silica deposits and general operating conditions have been improved in comparison with the period prior to the introduction of the hydrogen zeolite process.

The effect of the hydrogen zeolite process upon the volume of boiler blowdown water has been to reduce it 63 per cent, from 4.4 per cent to 1.6 per cent of the total boiler feedwater, composed of about 48 per cent condensate and 52 per cent treated make-up.

Corrosion of Steam

Under the sodium zeolite treating system, the presence of a high alkalinity in the raw water supply always produced an undesirable amount of free carbon dioxide in the steam and condensate as a result of decomposition of the bicarbonate at the boiler pressure and temperature. The following data show the effect of the hydrogen zeolite installation upon the potential and free CO_2 contents of the boiler feed and condensate, respectively:

Volume sodium zeolite effluent in make-up	100%	42%
Volume hydrogen zeolite effluent in make-up	0%	58%
Potential CO_2 Content Treated make-up water, p.p.m.	164	31
Total boiler feedwater, p.p.m.	90	15
Actual CO_2 Content Returned condensate, p.p.m.	130	20-40

The potential CO_2 content of the boiler feed has been reduced to 17 to 19 per cent of the former amount and the actual free CO_2 content of the returned condensate to 23 per cent. While a direct proportion relationship may not exist between free CO_2 content and resultant corrosion, the corrosive action of the condensate undoubtedly has been reduced.

Chemical Consumption

Chemical usages for the new hydrogen zeolite unit and for the two reconditioned sodium zeolite units amount respectively to 23.6 lb. H_2SO_4 per 1000 cu. ft. and 29.0 lb. or 17.2 lb. NaCl per 1000 cu. ft., depending upon whether or not 45 per cent of the NaCl used is salvaged by operation of a brine recovery system.

Table III—Properties of raw and treated water

	Well Water mg/l	100% Sodium Zeolite Water mg/l	100% Hydrogen Zeolite Water mg/l	58% Hydrogen Zeolite Water 42% Sodium Zeolite Water (1) mg/l
Sodium—Na	52.2	130.2	3.0	56.0
Calcium—Ca	45.4	0.0	0.0	0.0
Magnesium—Mg	12.5	0.0	0.0	0.0
Hydrogen—H	0.0	0.0	1.6	0.0
Sulfate—SO_4	40.5	37.7	42.8	41.6
Chloride—Cl	29.6	31.0	29.6	30.3
Carbonate—CO_3	0.0	6.3	0.0	0.0
Bicarbonate—HCO_3	238.0	231.8	0.0	45.1
Silica—SiO_2	28.4	25.0	27.1	27.4
Iron and Alumina—R_2O_3	0.0	0.0	0.0	0.0
Total mineral matter	446.4	462.0	104.1	201.0
Free CO_2	1.1	0.0	28.0	1.0
Residue at 180 deg. C.	323.3	337.9	42.7	176.4
Alkalinity as Na_2CO_3	206.8	212.5	0.0	39.2
Hardness as $CaCO_3$, mg./L. (Calc.)	164.7	0.0	0.0	0.0
Hardness as $CaCO_3$, gr./gal.	9.6	0.0	0.0	0.0
Ratio: Sulfate as Na_2SO_4 / Alkalinity as Na_2CO_3	0.29	0.26	....	1.57
Potential free CO_2	172	167	28.0	32.5

(1) Samples after degasifier.

Table IV—Boiler water composites representative analyses

Make-up composition:	100% Sodium Zeolite	67% Hydrogen Zeolite 33% Sodium Zeolite	58% Hydrogen Zeolite 42% Sodium Zeolite	58% Hydrogen Zeolite 42% Sodium Zeolite
NaOH	1,660	208	308	440
Na_2CO_3	470	40	117	210
Total alkalinity as Na_2CO_3	2,667	315	525	790
Silica as SiO_2	350	825	455	749
Sulfate as Na_2SO_4	829	1,850	1,090	1,777
Mineral residue at 180 deg. C.	3,451	2,411	2,865	4,964
Ratio: Sulfate as Na_2SO_4 / Alkalinity as Na_2CO_3	0.31	5.88	2.08	2.25
Ratio: NaOH / SiO_2	4.7	0.3	0.7	0.6
Ratio: Total Alkalinity as Na_2CO_3 / SiO_2	7.6	0.4	1.1	1.1
Concentration factor, excluding effect of condensate, as indicated by Na_2SO_4	15.3	36.3	20.2	32.9

Diesels Function Under Unusual Conditions

REMARKABLE performance of Diesel engines under most unusual operating conditions was disclosed recently when a United States cargo vessel was torpedoed in West Indies waters. After being afire and listing heavily at the bow for approximately 40 hr., two of the ship's 8-cylinder Diesel engines, supplied by The Cooper-Bessemer Corp. were found to be operating perfectly.

According to the chief engineer of the ship, the torpedo struck forward, starting a large fire and causing the vessel's bow to submerge about 15 ft. Under this apparently hopeless condition, the crew was ordered to abandon ship and reached port safely.

Sighted by a patrol plane which reported the craft still afloat, a salvage crew was sent out, accompanied by the chief engineer, second engineer, second mate and some of the crew. The salvage crew succeeded in extinguishing the blaze in several hours.

The second engineer, who was the first to board the ship, was surprised to find the Diesel engines still running. The remarkable fact that the lubrication system of these Diesels still functioned perfectly after 40 hr., even though the engines were tilted at a steep angle, attests to the excellent engineering of full-pressure circulating type of lubrication, a feature of this type of marine engine.

—o—

SPLICES in cotton belts can now be made satisfactory for high-speed power transmission applications. This was accomplished through the development of a new waterproof cement which, according to Westinghouse experts, makes a smooth, permanent splice.

Victory in the Grounded Air

The importance of air power on the many military battle fronts of this global war is well established. And another kind of air power is also playing a vital part on the industrial front at home—namely, that of compressed air. Most industries, large and small, that are serving the war effort are generally dependent upon an adequate and reliable supply of compressed air to achieve effective performance. So important is this life-blood of many war industries that, aside from a few small sizes and types, air compressors for some time have been subject to virtual allocation. It therefore behooves the user to exert the utmost care in selecting equipment best fitted to his needs and also in securing maximum, economical results from his present compressors

by Wm. H. Wheeler, Compressor and Air Tool Dept., Worthington Pump & Machinery Corp.

WHOEVER originated the expression "free as air" wasn't talking about compressed air, because that kind of air costs money and power. Therefore, every reasonable precaution should be taken to prevent its waste. A leak in a fuel oil line would not long go unrepaired. Yet such a leak may be no more costly than those that exist in compressed air lines of many industrial plants today. For instance, a ⅛-in. opening in an air line will waste nearly $50 worth of compressed air per month; a ¼-in. leak almost $200 per mo., a ⅜-in. leak approximately $400 per mo. Not only is this waste of money deplorable but, in most cases, it represents a direct loss of the power that is so vital to our war effort.

Air Leaks

Air leaks usually go unnoticed. No red light flashes when they exist. A practical way to check an air system for tightness, however, is to note how much the pressure drops with the compressor stopped and with no air being consumed. If the pressure falls more than 5 lb. per hr., some real money can be saved by tracking down the little thieves that are stealing this valuable air. Fortunately this isn't a very arduous task, requiring only some soapy water and a paint brush. Test all pipe, valve, and fitting connections carefully and make this an established maintenance routine. Enough money may be saved in this way to buy a sizeable Victory Bond each month.

Sometimes other losses, as great as those resulting from leaks, arise from an air system being in poor condition. Air lines installed many years ago may be too small to carry the present load, particularly if more compressors have been installed. Such a system can be compared with a person suffering from high blood pressure. This can easily be checked by noting simultaneously the air pressure at the compressor and at a remote point of use.

If this difference is more than a pound or two, excess power is being consumed to overcome the restriction to the flow of air caused by lines being too small. This condition can frequently be relieved by installing a receiver or air tank close to the remote point of use, to act as a reservoir when the air demand is heavy. Of course, larger lines will always correct the trouble.

What to Do About Moisture

The accumulation of moisture and condensed oil vapor in air lines is a difficulty that seems to beset most industrial air systems. This condition is due to the cooling of air in the lines after it leaves the compressor, and arises from the simple phenomenon as is evidenced when blowing one's breath against a cold window pane, or in the formation of dew in the cool of the evening.

Not only does this condensate cause rusting and scaling of lines, but it gums up paint-spray guns, sandblast nozzles and delicate control mechanisms, and washes away

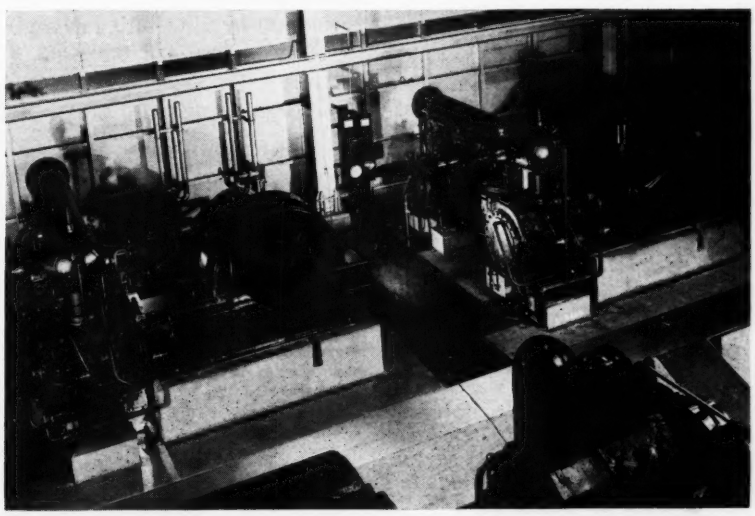


Fig. 1. Two horizontal synchronous motor driven compressors with control coordinated to provide a uniform air pressure with minimum power consumption

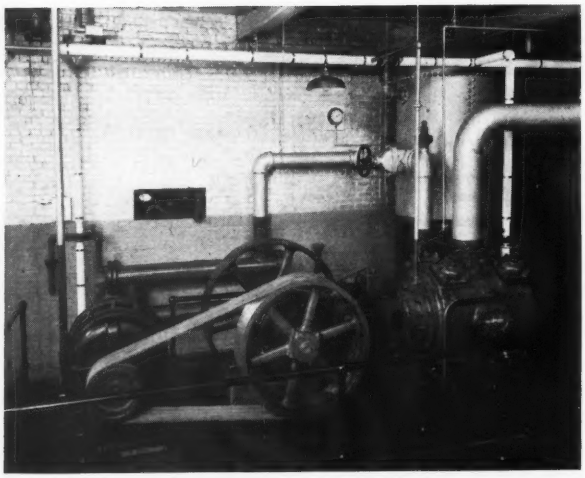


Fig. 2. This modern compressed air plant assures a reliable supply of clean dry compressed air for helping produce America's war materials

the lubricants of air tools. It wastes air-power and man-hours because it often requires blowing down of air lines before the air can be used satisfactorily.

No amount of traps and separators will rid the air of this oil and water emulsion if there is further cooling beyond the point of separation. The most practical way to obtain the bone-dry air that puts new vim and vigor into air-operated devices, is to cool it after it is compressed, and thus separate the condensate from the air.

The equipment required to do this job is simple and inexpensive, and is known as an aftercooler. Air leaving the compressor is run through it and is cooled to within a few degrees of the temperature of the available cooling water. Larger aftercoolers have integral separators for diverting to the sewer the condensate which is trapped. For air pressures of around 100 psi, 1 gal. of water will effectively cool 100 cu. ft. of free air

So important for industrial operations is dry compressed air that aftercoolers are now built for small compressors, even those of fractional-horsepower sizes. In the smaller sizes, the air tank serves the dual purpose of a receiver and separator, and is fitted with a trap for automatically draining the condensate.

Compressor Face-Lifting

Even air compressors may undergo operations which will rejuvenate them. Some industrial plants, converting to war work, may find their present compressor equipment unsuited for meeting changed conditions. Before discarding such old equipment in favor of new, it would be well to find out first whether it is capable of undergoing any of the several available face-lifting operations. If such is possible, considerable money, time, and scarce materials may be conserved.

As an example, a plant using process steam may find, in converting to war work, that it would be prohibitive to operate high-pressure boilers merely to generate steam for a steam-driven compressor. Instead of buying a new motor-driven unit, it may be possible to remove the steam cylinders, apply a suitable pulley, and drive the compressor by V-belt from a motor.

Again, a compressor may be built for operating at higher pressures than those required under changed conditions. If of the conventional double-acting horizontal type, a remarkable increase in output is sometimes possible merely by changing the cylinder and piston. As an example, on one size of compressor built for 125-lb. discharge pressure, the delivered capacity at 100-lb. pressure can be increased 44 per cent by substituting a larger 100-lb. cylinder and replacing a 50-hp. motor with a 60-hp. motor.

Increase in capacity is naturally much greater with a wider difference in pressures. Any cylinders so replaced may of course be set aside and reinstalled when normal conditions return. The savings in man-hours, time, and money, effected by such changeovers, fully justify the effort.

Vast improvements in compressor control have been made in recent years, in order to produce compressed air most economically for any specific requirement. On motor-driven compressors above 100 hp. where air demand varies, multi-step types of control are still widely used. The only disadvantage of such control has been that an excess of pressure (and power) is required to completely unload the compressor, since the control is responsive only to pressure increase over a fairly wide range.

Contrasted with this, a compressor with the most modern type of step-control seeks its minimum load (and power) level, to maintain a constant discharge pressure. The excess pressure and power is thereby saved. A saving of 3 per cent in power input to a 500-hp. motor totals about 8000 kw-hr. per mo.

Since this improvement arises from the controlling instrument itself rather than from the compressor, such modern controls can be applied to many large compressors that have seen years of service. Not only is power saved, but a uniform instead of a varying pressure in the air system is the result of such face-lifting.

Many war plants today find it necessary to augment their air systems with additional compressors due to increased air demand. Unless the control of new units is co-

(*Continued on page* 134)

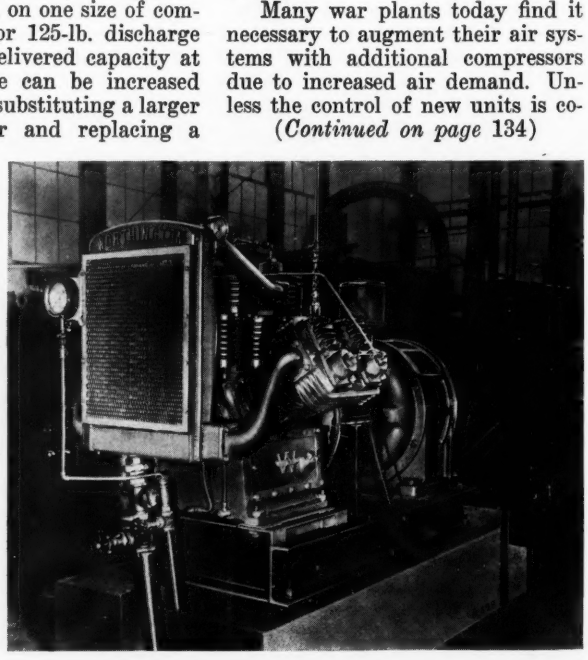


Fig. 3. Typical compressor to which Dual Control is applied so it may be operated either automatically (for intermittent load) or under constant speed control (for uniform demand) at operator's option

The PRACTICAL ENGINEER and ELECTRICIAN

ANDREW W. KRAMER, EDITOR

NOISE, WIND AND RAIN

Very little, if any, effort has been made to reduce the amount of noise in the average power plant. Noise, it is felt, is the inevitable concomitant of power plant equipment in operation and little thought is given to it. Noise, however, can be extremely detrimental as was proved in the following incident which occurred not long ago.

At the plant in which this trouble occurred, purchased electric power is delivered to the main switchboard at 2300 v., 60 cycles. During an evening when a violent wind storm accompanied by rain hit the plant a large window back of the main switchboard blew in but because the turbine room was very noisy, the operator on watch did not hear the crash. The result was that the rain came in and as some of the water found its way into the switchgear, it (the switchgear) let go with a terrific bang and as the operator explained, had it not been for the roof, he would have been going straight up yet. He almost swallowed the cigar he was smoking. Well, it was 24 hours later when the current was cut in again. Inspection showed definitely that the damage had been caused by water getting into the main circuit breaker.

Accidents can happen but the point to be made clear here is, that if this turbine room had been less noisy, failure of the electrical apparatus would not have occurred. The operator would have heard the window break and would immediately have taken steps to keep water out of the equipment.

The measurement of noise and its elimination is much more of a science these days than it once was, and power plant designers would do well to apply the principles of noise reduction in the design both of equipment and the plant as a whole.

A.W.K.

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A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

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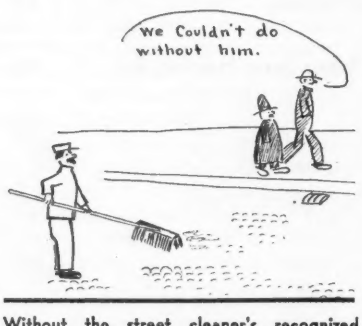
BORN THAT WAY

A bit of Popeye's "I Yam What I Yam" philosophy directed particularly to the operating engineer's yen for the smell of steam and things that run by steam and presented with apologies to Johnson O'Connor[1]

By Andrew W. Kramer

One of our good subscribers, in commenting on the article, "Pass The Ammunition" in the January issue, and who feels that the operating engineer is about on the same economic level as that of a street cleaner but without the street cleaner's recognized place in society, ends his letter with this declaration, "No, Mr. Editor, I don't believe the game is worth the candle. As for myself, however, I love the sound of steam, the working of a steam engine—love to make them work." Following this he implies that he is going to get out of the game, and



Without the street cleaner's recognized place in society

if need be, fill "God's urge" by running a toy steam engine.

Brave words, these, sincerely spoken no doubt, but his whole attitude belies his threat. Whatever his feelings at the moment his very love for his engines will prevent him from carrying it out. The answer to the whole question of the operating engineer's lowly status lies largely in his fundamental love of engines and things that run mechanically. It has its roots in what James Norman Hall has called the "steam engine outlook on life". It is part of his heritage. He cannot help himself—he was born that way.

The average operating engineer is not a physicist but knowingly or not he shares the physicist's interest in knowing how things work—what makes them go. Most operating engineers are not college men; many have had little formal training in physics or mathematics, yet, somehow they easily grasp complicated mechanical principles and seem to have an inherent understanding of natural laws that are baffling to people in other fields of human endeavor even though these people may be possessed of a more extensive general education.

Two Kinds of People

This characteristic marks a fundamental difference in people—those who are naturally interested in mechanical things and those who are not; those who in high school and college, take to physics and those who detest it. In general this is a difference between men and women. There are numerous exceptions of course but boys exhibit a much greater interest in physics in high school and college than do girls. But even among men there is a wide variation in interest in mechanical things. Some men hardly know how to drive a nail into a board; these are the same men who have little aptitude for understanding natural phenomena.

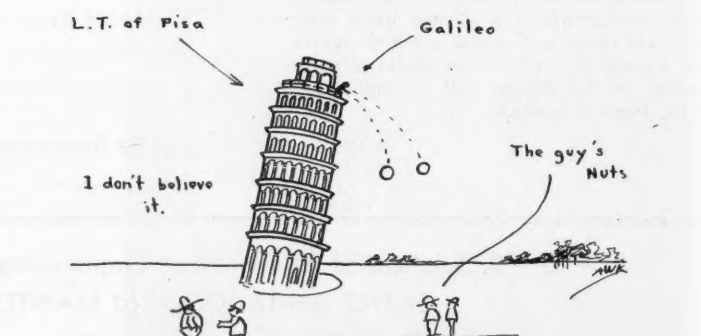
Those endowed with this inherent interest in natural phenomena are fortunate because to them the world is a source of never ending interest. To such people, provided they have had an opportunity to develop this interest, a streak of oil on the surface of a street puddle becomes a demonstration of interference phenomena; in the iridescent colors of the oil film, they see a manifestation of the interchange of energy between atoms. It starts a train of thought which, if continued, may lead to a consideration of the second law of thermodynamics in its most serious implications, that involving the ultimate death of the universe.

So what, one may ask; suppose it does, does that make them any happier? Perhaps not; happiness is not a matter of knowledge but an understanding of natural phenomena gives one a feeling of closer relationship with the world, it makes it less a place of mystery. Sometimes an interest in such apparently trivial things as an oil film leads to big things. Irving Langmuir's interest in such films lead him into a study of molecular layers and this opened up an entire new field of research, that of surface chemistry. To many, the idea of a great research chemist playing with soap bubbles in the laboratories of the General Electric Co. might have seemed silly but this interest in these soap films has paid rich dividends. It was these films that led to the development of non-reflecting glass.

It Was Not Always Thus

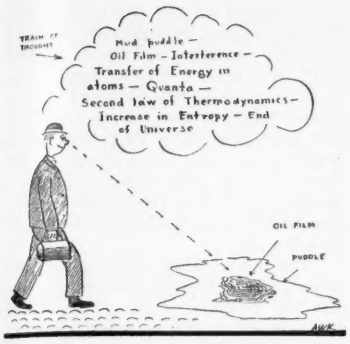
There was a time when no one knew anything about the physical laws of the universe. A rainbow, then, was a sign of God; lightning was a sign of the Devil. The colors of an oil film had no significance whatever. Such explanations as were attempted were founded upon the supposed characteristics and dispositions of the gods, and instead of giving satisfaction they bred fear and superstition.

It was not that people had not thought about such things. From the earliest times in the history of mankind people wondered about things—why the sun rose in the morning and set at night, what fire was, why the wind blew, why iron sank and cork floated. The superstitions they formed showed that they thought deeply about them but few made any experiments to find out why they were so. There was, in fact, a strong prejudice against doing the experiments on the grounds that this involved tampering with the will of the gods. They had great faith in their reason. If it seemed logical that a heavy body would fall faster than a light one, they merely concluded that it did. Even when Galileo proved that this was not so by dropping bodies of different weight from the



They thought Galileo was a dope

[1]Johnson O'Connor of The Human Engineering Laboratories wrote a book a number of years ago called "Born That Way" which deals with the measurement of inborn aptitudes. Those interested in persuing this subject further will find this book of great interest.



What a streak of oil can do

Leaning Tower of Pisa they still preferred to believe what they had always believed rather than face the facts.

There were a few curious beings, however, who, like Galileo were not content just to form ideas, and who made some attempt to see how things really worked. These people were the first scientists, the first researchers. They had few starting points, however, and every phenomenon they encountered had to be tested. The early alchemists worked in the dark, figuratively as well as literally. In a world hostile to new ideas, they had to be careful—they worked in secrecy. But they were endowed with the will to know and with the desire to dig out nature's secrets and that was their great asset, just as the will to know and understand is man's greatest asset in any field.

It is this inner urge, this will to know, that gives the operating engineer his "feel" for his engines and turbines today. Whatever environment or education contributes to his knowledge, a man who finds his way into the field of power plant operation usually has decided mechanical aptitude to start with. He may have been taught certain things, he may have picked up certain principles of physics and mechanics but his ability to assimilate such knowledge was always a part of himself.

The Real Source of Knowledge

In a splendid little book on physics[1] recently published—not a textbook but a book discussing the nature and philosophy of physics—by Professor W. F. G. Swann of the Franklin Institute, he discusses this will to know. In a literal sense, he says, there is no teaching, there is only inspiration to learn. Knowledge, he points out, comes from within, outwards, rather than from without, inwards.

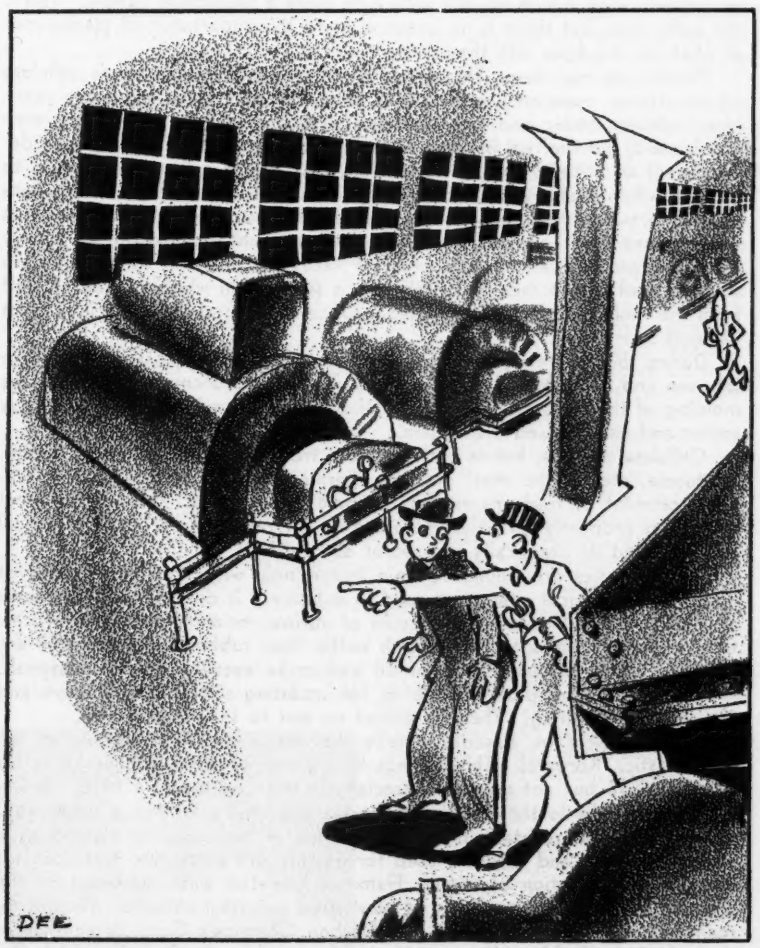
The operating engineer's attachment for his engines likewise comes from within. No doubt, there are plenty of operating engineers who have been taught what they know about their work and who do not possess this inner feeling for steam or electricity; they may be very successful engineers from an executive or management standpoint because they may regard operation only as a means to an end, but they are quite a different sort of an animal from the breed to which our correspondent belongs.

In these days of speed and intense competition for wealth and position, it may seem archaic to preach knowledge for its own sake, and in these columns we, ourselves, have endeavored to advance the economic status of the engineer, but in the final analysis, this, "knowledge for its own sake" may be the answer to his problem. The engineer gets a certain satisfaction out of his job that in some way compensates for its shortcomings in other ways. As expressed in Kipling's McAndrew's Hymn,

> "But no one cares except mysel' that serve an' understand
> My seven thousand horsepower here. Eh Lord! They're grand—they're grand!"

All this may be poor solace to the hard working operator who is trying to make both ends meet, and who, despite his love for the sound of his engines feels discouraged. To him, we should like to point out that his economic status is something entirely apart from his instincts as an engineer, and that the acceptance of the one does not rule out the chance of progress in the other. In a world that is becoming more conscious of the importance of power with each passing day, his chances of achieving recognition and financial reward are greater than ever before. Rather than give up the profession and satisfy his instincts with a toy engine, let him preach his virtues instead of hiding them under a bushel. He may discover that he is a better salesman than he thinks he is.

Maybe he's a better salesman than he thinks



"You go down that way 25 Diesels and then 12 to the right and yell for Harry."

[1]Physics. By W. F. G. Swann. John Wiley & Sons, Inc.

Plastics You Should Know

KOROSEAL—What it is, how it behaves and what it can be used for.

KOROSEAL is a comprehensive name used commercially to describe a group of resins developed by The B. F. Goodrich Laboratories. This development was based on the discovery by Semon, that polyvinyl chloride resin formed workable rubber-like materials when certain high-boiling-point organic liquids (plasticizers) were combined with it. The discovery led to the development of a great variety of products varying from soft gels through rubber-like materials to hard, horny plastics.

Outstanding among the properties of the polyvinyl chloride resin are its unusual chemical inertness and resistance against corrosion. These characteristics are, in fact, the basis of the name "Koroseal"—a seal against corrosion.

The Chemistry of Koroseal

The chemistry of Koroseal may be explained simply by the manufacturing flow chart shown in Fig. 1. Basically, the process consists of three main steps: in the first, vinyl chloride is prepared; in the second, vinyl chloride is converted or polymerized to the resin, polyvinyl chloride; and in the third, the resin is plasticized to form Koroseal.

As shown on the chart, vinyl chloride is prepared commercially by catalytically uniting hydrogen chloride and acetylene, which two gases have been previously prepared by well-known methods using water, salt, coke and limestone. The vinyl chloride so prepared is a gas under normal conditions but for convenient handling is usually liquefied by cooling or compression to below its boiling point of minus 13.8 deg. C.

The molecule of the chemical compound, vinyl chloride, like many others, has the peculiar ability of combining with itself to form giant chain-like molecules. The process of producing these giant molecules is called polymerization and the products formed are identified as polymers. The ever resourceful chemists have incorporated the name of this process in the terminology of the products, thus, polyvinyl chloride.

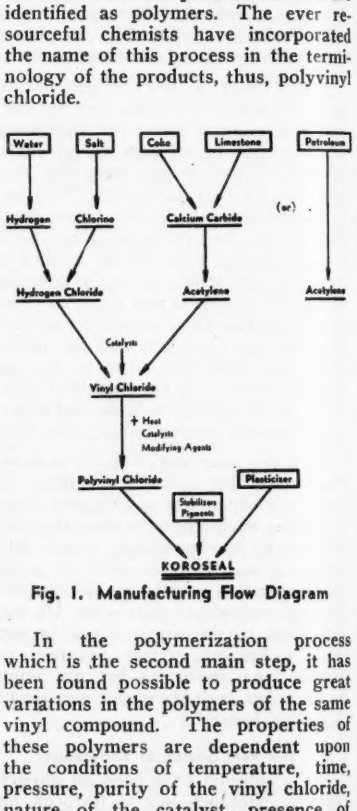


Fig. 1. Manufacturing Flow Diagram

In the polymerization process which is the second main step, it has been found possible to produce great variations in the polymers of the same vinyl compound. The properties of these polymers are dependent upon the conditions of temperature, time, pressure, purity of the vinyl chloride, nature of the catalyst, presence of modifying agents and mechanical treatments prevailing during the polymerization reaction.

After the resin polyvinyl chloride has been obtained, the last step in producing Koroseal is the plasticization of the resin. This plasticization process is ordinarily one of mixing the resin, plasticizers, stabilizers and pigments together in a "dough" type mixer and then placing this mixture on warm friction mills or rubber mills. On these mills the mixture first forms a rough sheet and, as the mixture is "milled" or worked, finally forms a smooth, homogeneous, plastic mass suitable for extrusion, calendering, molding or other forms of final processing.

The basic polymers used in Koroseal compounds may be given a wide range of physical properties by con-

---

Plastics is a term which these days is almost synonymous with magic. So many things are being done with plastics that to the layman almost nothing is impossible when plastics are mentioned in his mind it is as simple to build an airplane wing out of plastics as it is to make a toothbrush handle. This is not quite true, but there is no question as to the importance of plastics nor of what can be done with them.

Plastics are not new. The daddy of all our modern plastics is cellulose nitrate, known commonly as celluloid, which has been used for many years. Hard rubber, shellac and cold moldings were the next to appear and were widely used, but the real impetus to the use of plastics resulted from the development of Bakelite (phenol formaldehyde). Bright colors were added to the field when Beetle, a urea formaldehyde was introduced about 1930. Both phenol formaldehyde and urea formaldehyde are thermosetting materials which means that their molding is not merely a mechanical operation. Under heat and pressure a chemical reaction takes place which so changes the material that it becomes, while still hot, a solid piece which can be ejected from the mold without being cooled. Once so formed the material cannot be used over again.

During the last few years other plastics, called thermoplastics have come into use and have gained wide ground. There is no chemical change in the molding of these materials and when they are again subjected to heat they soften and can be used over again.

Cellulose acetate, known under various trade names as Lumarith, Tenite, Plastacele, etc., is the most common thermoplastic. Polystyrene, also with an assortment of trade names has become widely used. Perhaps the most significant properties of polystyrene are its low power factor as an electrical insulator, and its practically zero water absorption.

Since plastics are bound to gain increasingly wider use in all types of power and electrical equipment used in industry it is desirable that we know something about the nature and uses of various modern plastics. For certain purposes plastics are very much better than rubber. Certain ones are highly resistant to the effects of oil and make excellent gasket materials. Others are used for pipe and tubing, for insulating electrical conductors and for conveying belting. There is almost no end to their application.

In this article we describe briefly the nature and uses of one of the vinyl plastics, Koroseal. This belongs to a group of resins discovered as far back as 1838 but not used commercially in this country until 1928. It belongs specifically to the class known as the polyvinyl chlorides, a tough, rubber-like material resistant to oils and acids, it can also be classed as a synthetic rubber and is widely used for gaskets and protective tank coatings and for the insulation of wires. Flamenol insulated wire, marketed by the General Electric Co., is a form of plasticized polyvinyl chloride. Vinylite Q, manufactured by the Carbide and Carbon Chemicals Corp. is another of the polyvinyl chlorides. Koroseal is manufactured by the B. F. Goodrich Co.

trolling the molecular weight of the polymer. Variation in the molecular weight may be approximately indicated by differences in measurements of the specific viscosities of the pure polymers. The low molecular weight polymers have rather low specific viscosities which may approach 0.25. The high molecular weight polymers which are used in most Koroseal materials have specific viscosities approaching 0.70. These high molecular weight and correspondingly high specific viscosity polymers are very tough and hard. A study of the physical properties of the polymers compounded as shown in Fig. 4 indicates that the tensile strength and hardness increase rather rapidly as the apparent specific viscosity of the polymer increases.

In order to evaluate the chemical stability and inertness of the polymers in synthetic rubber-like materials it is of interest to the users to know at what rate they may expect deterioration. Because of the inherent chemical inertia of polyvinyl chloride it was at first difficult to evaluate the stability of the various polymers produced in the laboratories. However, a special test has been designed in order to make analytical comparisons. This test is based upon the deliberate decomposition of the polymers at excessive temperatures and measures the quantitative evolution of acid gases.

Many polymers have been studied and compared by means of this test. It has been determined that of all the rubber-like vinyl compounds, the specific polymers used in Koroseal exhibit by far the lowest rate of gas evolution. These polymers evolve gas when subject to heat at 150 deg. C. (302 deg. F.) at the rate of only 0.01 per cent by weight per hour which is conveniently expressed in the laboratory as milligrams of gas per 100 grams of polymer per 3 hr. At temperatures lower than 150 deg. C. the rate of gas evolution is so very slow that it is impractical to make the test.

It is also of interest to note the appearance of the polymer after being subjected to this excessive heat for a period of 3 hr. The vinyl chloride polymers used in Koroseal remain in their original powdery condition and exhibit only very slight discoloration whereas many vinyl polymers greatly discolor, suggestive of carbonization, and become tarry and sticky.

Although Koroseal is extremely inert and insoluble, there is a relatively small group of materials that may be harmful to Koroseal products. Among these are:

Acetic anhydride
Aliphatic or aromatic ketones
Aromatic amino compounds
Lacquer solvents
Organic compounds containing chlorine, bromine or nitro groups.

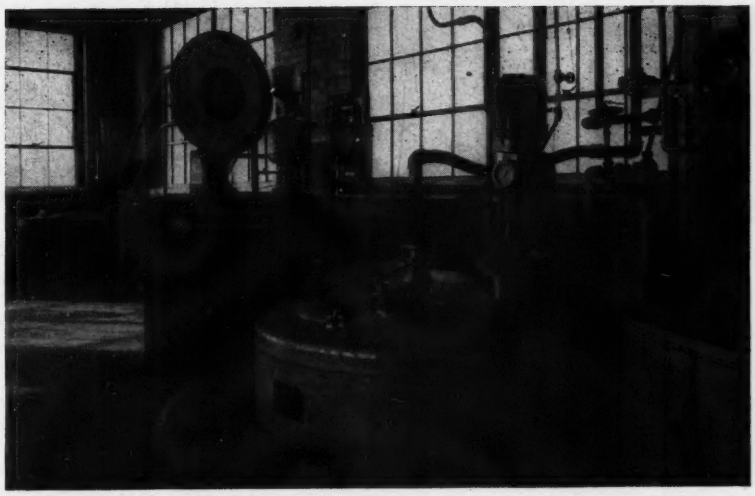


Fig. 3. A polymerizer for making polyvinyl chloride

Physical Properties of Koroseal

The physical properties of the many types of Koroseal compounds are dependent upon the molecular configuration and weight, and characteristics of the basic polymer, the kind and amount of plasticizers and stabilizers, reinforcing agents, fillers, or softeners present.

Koroseal resists oxidation, — the deadly enemy of rubber,—almost indefinitely. Accelerated aging tests destroy even the best rubber compounds in a relatively short time whereas the tensile strength of Koroseal shows no appreciable change even after 2 mo. in a circulating air oven at 70 deg. C. There is a small loss of plasticizer on these tests which sometimes decreases the elongation slightly.

The resistance of this plastic to corrosives has resulted in extensive application as an insulator on plating racks, where oxidizing acids such as chromic, nitric, and sulfuric are particularly harmful to most materials.

Another enemy of rubber compounds is oil. Generally speaking, oil has little effect upon Koroseal compounds except to extract some of the plasticizer in the softer types. For this reason it has found many applications as gaskets and as sealing members of reciprocating parts.

Koroseal is practically unaffected by sunlight and water, which has led to its extensive use in a great variety of weatherproof materials.

It is also gas resistant. This gas resistance and diffusion resistance makes it useful in balloon fabrics and in many other ways where the flow of gas is to be prevented or controlled.

Plasticizers

Plasticizers, as the name implies, are here defined as that group of organic materials which are capable of mixing with polyvinyl chloride to convert it from a hard, horny, relatively intractable material to a thermoplastic, workable homogeneous mass. These materials when added to the polyvinyl chloride in small quantities produce a comparatively hard, workable thermoplastic and as the percentage of plasticizer is increased the product becomes progressively softer. When relatively large quantities of plasticizer are added the product becomes a gel which is capable of being poured when heated.

As possible plasticizers for polyvinyl chloride, the B. F. Goodrich Laboratories have investigated a total of over 500 organic materials; of this 500, over 200 were synthesized in these laboratories. Most of the plasticizers are aromatic ethers, ketones, esters, chlor-esters and similar sulfur-compounds of which, the chlor-esters and esters are the most important. In the latter group are two of the most commonly used plasticizers, tricresyl phosphate and dioctyl phthalate.

Uses of Koroseal

The many hundreds of products that are made of Koroseal may be divided into three main categories which are best classified according to the ultimate use of the product,—chemical, electrical and mechanical.

Fig. 2. Basic ingredients of polyvinyl chloride used in Koroseal

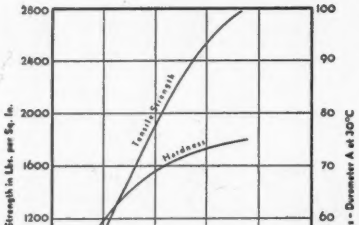


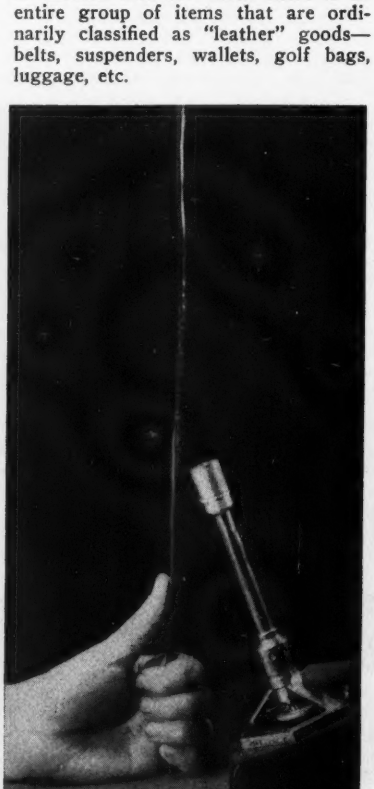
Fig. 4. The change in tensile strength and hardness of Koroseal compounds as the apparent specific viscosity of the polyvinyl chloride is varied

The chemical resistance of Koroseal is of prime importance in its use as an insulator on plating racks. Other chemical applications are many and varied, such as coatings for oil and gas pipe in particularly corrosive soil conditions, tubing for piping chemicals, transparent beer tubing, acid resistant fabrics, gas resistant fabrics, gas masks, and all types of weatherproof and protective coatings, even food packages, oil containers and bottle seals.

The electrical applications have coincided with almost the entire field of rubber insulation and jacketing materials and because of the excellent physical properties of Koroseal have superseded old types of construction where a combination of many materials was necessary to obtain a finished product. Its smooth finish, its inherent strength and its excellent flame resistance have meant that wire may be insulated with a thinner wall than was formerly necessary. Unlike rubber, no saturated braid need be applied over the new insulation to obtain a smooth, mechanically strong, flame resistant finish capable of withstanding the abuse of installation and subsequent weathering. This reduction in the over-all diameter of the wire has made it possible to put more wires in a single conduit and by this means to increase the capacity of old installations by rewiring without the expense of tearing out conduits. This is of particular interest in view of the modern increases in lighting loads. The flameproof qualities of Koroseal are outstanding, for not only does it refuse to propagate flame but it does not support combustion after an applied flame has been removed. It has further been used as a flexible tubing placed over copper rods, as molded electrical plugs and flexible insulators of all types.

Koroseal's electrical characteristics are headed by an outstanding dielectric strength which in many cases is over 1000 v. per mil of insulation thickness.

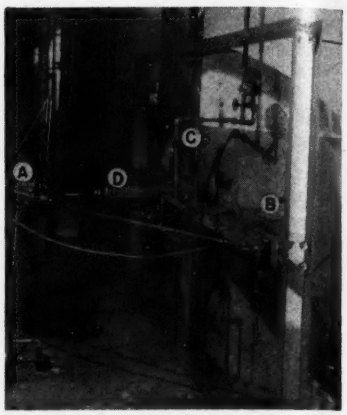
There are certain outstanding utilizations of Koroseal that are primarily mechanical such as shock-absorbing sponge, gaskets on mechanical equipment, conveyor belting and all types of molded articles. Then there is an entire group of items that are ordinarily classified as "leather" goods—belts, suspenders, wallets, golf bags, luggage, etc.



Figs. 5 and 6. Koroseal is flame resisting . . . during and immediately after applying a gas burner flame to a Koroseal-insulated wire

Window Washing Safety

HARNESS used by window washers should be tested periodically. A machine to do this, designed by Bill Otto, chief engineer of Carson Pirie Scott & Co., Chicago, Ill., is shown by the photograph. The harness to be tested is fitted to the semi-circular spider A, with the ropes attached to the clips on the frame B.



Hydraulic cylinder used to test window washers' harness in a Chicago Department Store

Water, under 50 lb. pressure from the roof tanks, is admitted through the control valves C to the 3 in. diameter, hydraulic cylinder D. This puts a thrust of over 350 lb. on the ropes. The spider A flexibly attached to the piston rod, is supported from the floor by an iron pipe stand, mounted on rubber wheels so the entire assembly follows the piston rod in and out without subjecting it to an eccentric thrust.

Escalator Tread Cleaner

POWER DRIVEN brushes are used to clean escalator treads in the Carson Pirie Scott & Co. department store in Chicago. The machine, designed by Bill Otto, chief engineer, and built in the store shops, is shown by the photograph. It consists of brushes spaced to fit the treads and driven by a ¼-hp. motor through a Boston bevel gear and roller chains.

Power driven brush used to clean escalator treads

The whole thing is mounted on rubber wheels with a latch, A, to hold the brushes off the floor when being wheeled from one part of the store to another. The shaft, mounted on ball bearings, also acts as a pivot so that the required chain lengths remain constant regardless of the angle of the tilting brush table.

POWER FUEL PRACTICE

Storing Coal

WITH REFERENCE to the section on the storage of coal presented in the July, 1942 issue of POWER PLANT ENGINEERING, W. T. Brown, Research Engineer for Jones & Laughlin Steel Corp. has directed our attention to a new method of coal storage not mentioned in any of the articles in the July issue and on which he has been granted a patent. This patent (No. 2,251,321) was issued Aug. 5, 1941 and assigned to the Bethlehem Steel Co. where the method is now in use. This method, he points out, was described in the November, 1941 issue of "Blast Furnace & Steel Plant" and aims to prevent the oxidation of coal in storage.

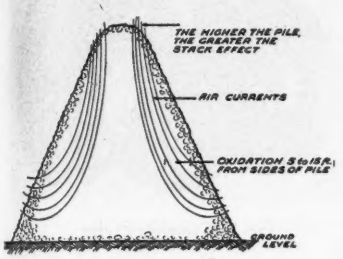


Fig. 1

It is well known to those who store coal in large quantities, that there is an upward passage of air through the pile and that the greater the flow of air the greater the oxidation of the coal. This flow of air is shown graphically in Fig. 1. Particularly is this oxidation rapid when the coal is low in volatile constituents, when it is wet, and when it is fine or in small lumps. The greater the oxidation of coal the more are its coking properties and the yield of phenols and cresols reduced, and for this reason coal that is to be used for the manufacture of coke should be especially well protected.

It was found, for instance, that low volatile coal from the lower Kittanning seam, crushed to a fineness of 50 per cent through a ⅛-in. screen, oxidized to such an extent in 3 mo., when piled to a height of 15 to 20 ft., and when the coal had reached a temperature of 120 deg. F., that its coking properties were destroyed, and the coke that came from the ovens was largely in granular form.

The patent covers a method for preventing the passage of air through a pile of coal. As the coal is received it is spread on the ground to a height of somewhat less than 10 ft. This layer is leveled and preferably compacted by a roller or a bulldozer in order to decrease the spaces through which air can travel. Over this layer, and its sides as well, there is then spread a covering of Sisalkraft paper, and on this more coal, which is also covered with Sisalkraft. Other layers of coal are similarly laid and covered, as shown in Fig. 2, until the pile is completed. The paper on the sides and ends of the pile is held firmly in position by covering it thinly with coal. When thus protected there can be no passage of air through the pile.

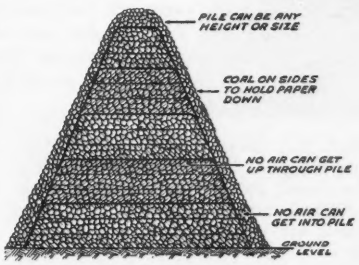

PILE CAN BE ANY HEIGHT OR SIZE
COAL ON SIDES TO HOLD PAPER DOWN
NO AIR CAN GET UP THROUGH PILE
NO AIR CAN GET INTO PILE
GROUND LEVEL

Fig. 2

The effectiveness of this method of storing coal is readily demonstrated by the fact that coal in seams from 3 to 10 ft. thick has lain for thousands of years in mines where it was covered by hard rock or clay, and there has been no depreciation of its properties.

Checking Absolute Pressure Recording Gages

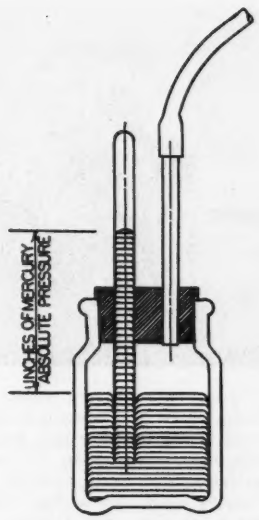
By CHESMAN A. LEE

ABSOLUTE PRESSURE recording gages have an inbuilt correction for barometric pressure. However, the mechanical adjustment for the pen does get out of adjustment and requires occasional correction.

It is easy to check these gages with a 34-in.-long glass tube and a jar of mercury. The foot of the tube is sealed below the surface of the mercury and the top is connected through a rubber tube to a pet-cock on the system under vacuum. Correction is made for the difference between 30 in. and the actual barometric pressure, when known.

Barometric pressures can no longer be obtained from the Weather Bureau. One can make his own barometer, but the long glass tube is difficult to prepare. It must be chemically cleaned, thoroughly dried out and then completely filled with mercury. Then the filled tube must be set in place with the lower end below the top of the mercury in the well, without letting any air into tube. It can be done but it seems foolish to fill a 34-in. tube to check only 2 or 3 in. of absolute pressure.

After Pearl Harbor I made up this design and put it into successful use. The sketch shows how two 5-in. long glass tubes can be used with a sealed well to check the absolute pressure directly. The one glass tube sealed at top was easy to prepare and the unit is easy to use. It is not delicate like a barometer and should be of interest to anyone dealing



Small mercury manometer for a few inches of mercury pressure, useful in checking absolute pressure recorders

in absolute pressures of 2 or 3 in. It is hardly necessary to mention that absolute pressure plus corrected vacuum equals 30 in.

Globe Valves Made by Arc Welding*

THE EXTENT to which arc welding can be applied in the fabrication of relatively complicated pieces of equipment is well illustrated by a process developed by H. C. Elliott of the Mississippi Valley Barge Line Co. for the construction of globe valves by means of arc welding. His description of this process presented in a recent issue of the Welding Engineer won the Hobart monthly arc welding contest.

By this process globe valves of all sizes from 2 in. up can be made for all pressures by welding from tubes, plates and bars. No special set-up is necessary for manufacturers to produce these valves on a production line basis since the wall thickness can be selected from standard sizes of tubing. Four and one-fourth-inch tubing is now made in 19 wall thicknesses varying from 16 gage to 1⅛-in. walls. Five-inch tubing is made in 17 different wall thicknesses—varying from 11 gage to 1 in. thick.

The S.A.E. 1035 steel tubing has much better physicals than cast steel. And steel welds better than any of the S.A.E. carbon steels. A valve body made from this tubing and stress relieved after welding would be almost equal to 6 per cent chrome-0.05 per cent molybdenum heat-treated steel castings.

	Tubing	Cast Steel
Tensile strength, psi.	103,000	74,000
Yield point, psi.	78,000	38,000
Elongation in 2 in., %	24	24
Reduction of area, %	62	35

Drawings show method of construct-

*Presented by special permission of The American Welding Society.

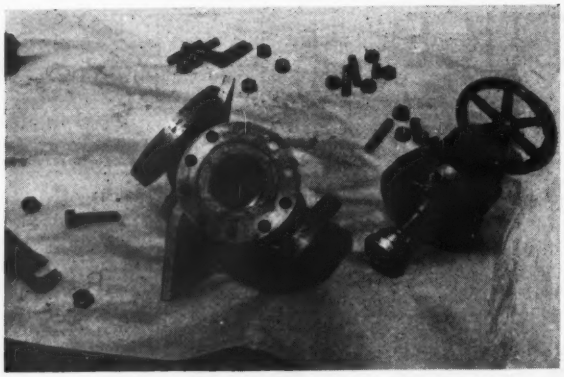


Fig. 1. Parts of the valve

ing a 2½-in. high-pressure valve by arc welding. First the transverse tube was sawed to the right length and a blacksmith swaged the ends. A large hole was burned vertically through the tubing, leaving ¼ in. for boring. Next, a machinist chucked the tubing and bored a hole through it so that the vertical tube would slip in it. Since the horizontal tube is only ⅜ in. larger in diameter than the vertical tube, the horizontal tube has just enough metal left to hold the two valves together after boring through it. But the small amount of metal is burned out after tacking together. (See upper left-hand corner of drawing Fig. 3-A-1.)

The vertical tube was sawed to the correct length and the top layer of Monel weld put in for the seat. Then the tube was turned on its other end and the rest of the bead run. With careful welding, this bead can be run without pinholes and flaws with Monel, stainless, stellite, bronze or mild steel electrodes.

Next, a templet was made to wrap around the vertical tube. This laid off the two slots for the inlet and outlet of the valve. These slots were burned neatly and trimmed with an air chipping hammer. The bottom of this tube was closed and it was slipped into the horizontal tube for welding. Welding details are shown on all of the drawings.

Welded tubes were chucked up and the top of the vertical tube and ends of the horizontal tube faced and chamfered for welding. Next, top plate and flanges were welded on. Now the body was ready for final machining which consisted of the following operations:

1. Facing three flanges (as shown).
2. Truing inside welds.
3. Machining seat to proper angle.
4. Drilling bolt holes.

The bonnet of the valve was welded in a simple fixture which held the tubing, plates and bars in position while being tacked and while final beads were run—bonnet required no preliminary machining of parts. It was chucked up only once for final facing of the bottom flange, boring of the two pieces of tubing, and facing the tubing at three places.

Packing gland consists of one piece of tubing with a plate welded to one end and machined to fit. Stem guide was made from stainless steel tubing and held in place by a light weld bead of Monel. The valve stem and disk is Monel—both of conventional design.

Using same rates of labor costs and overhead figures, a welded valve can be built for 52 per cent less than a cast-steel valve. A cast-steel valve (standard 2½ in.) weighs 200 lb. Similar valve of welded steel weighs only 100 lb. This 2½-in. welded globe valve is good for a working pressure of 1500 lb. and a total temperature of 750 deg. F. It was tested by hydraulic pressure to 5500 psi. The American Bureau of Shipping has approved this design as practical for valves for steam power plant equipment. Patent is pending on the method of construction and design.

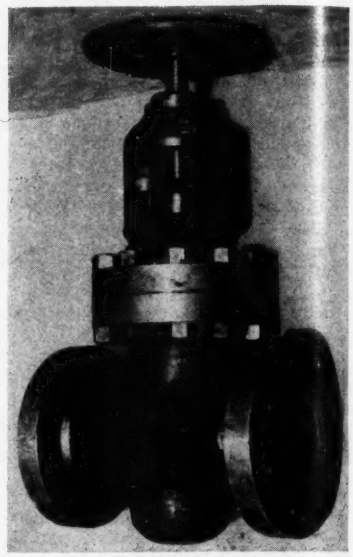


Fig. 2. Completed valve

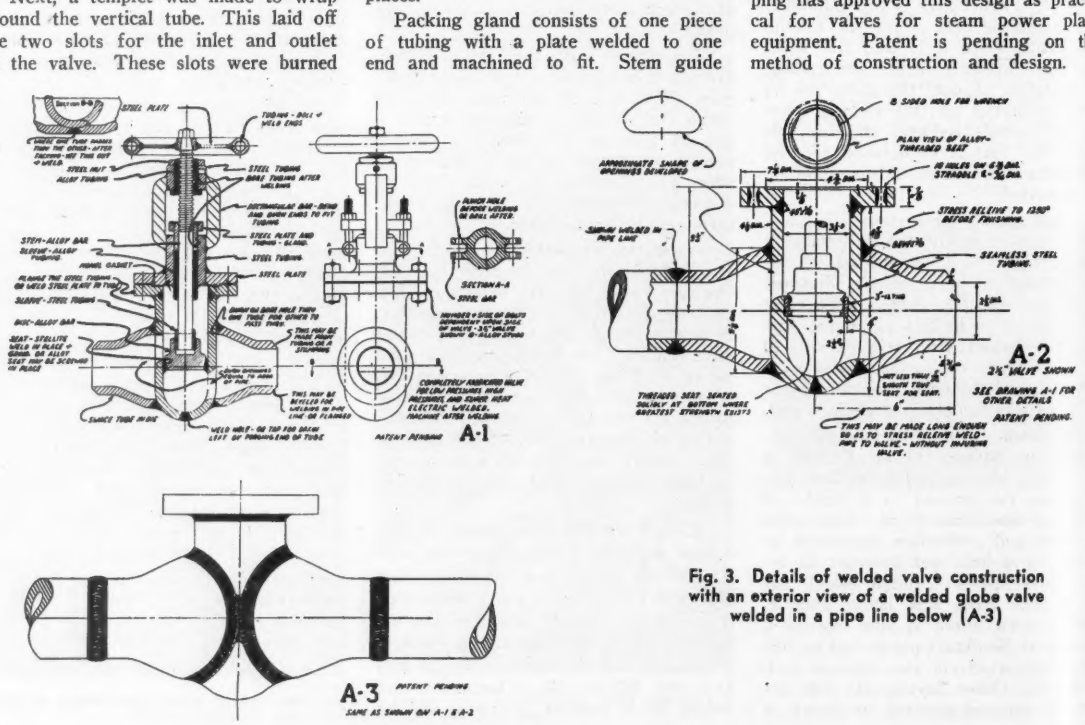


Fig. 3. Details of welded valve construction with an exterior view of a welded globe valve welded in a pipe line below (A-3)

Of Course The 65 Degree Ruling Saves Heat, But—

A recapitulation of the various and sundry comments and ideas evoked by Problem 26 in the January issue. Last month we presented the prize winning letters but because of lack of space were unable to comment on the many other fine letters received. The question was, does the 65 deg. ruling save fuel? A legal answer would be simple enough—yes, but engineers cannot answer questions as simply as that.

ON THE MORNING of February 2, the second day after the official close of the January Prize Contest, a great clicking and clattering, like castanets in a wild Spanish dance, issued from the chambers of the Chief Justice. People passing the room looked in expecting to see somebody in a shawl dancing on the desk or other such wild revelry. But there were no dancing girls, no hot tomatoes—there was nothing warm about the scene. The chattering was merely the chattering of the judges' dentures as they sat shivering in a temperature of 65 deg. trying to award the prizes. Outside the wind howled—and it snew.

There the judges sat shivering and moaning. There was frost on their whiskers and as they pawed through the contents of the bag of mail with their numbed hands they cursed the OPA, Harold Ickes and the bureaucrats generally.

"Sixty-five degrees! What nitwit suggested it? Saves fuel? Of course it does you old dodo—any fool knows that, but it congeals butter, and here we sit freezing to death." These were some of the comments.

It would be too painful to recount the acrimonious discussion that continued throughout the day. At various times messengers went out from the chambers returning each time with packages that looked as though they might contain bottles. The mystery of the packages was never fully solved but it was noted that after the arrival of each package the harangue inside increased both in tempo and intensity.

As already explained in the March issue, the B. of J. finally did award the prizes but by that time the members were in such a stupor, from cold or from other causes—we suspect the latter—that nothing really was known about the relative merits of the various opinions expressed in the letters received until we read them ourselves.

As we suspected and as was pointed out by the prize winning letters in the March issue, most of the contestants agreed that the 65 degree ruling did save fuel. As pointed out by Albert Fisch, Jr., Power Survey Engineer of R.C.A.-Victor Division at Camden, N. J., "There can be no conflict of thoughts on whether fuel is saved if the temperature is held at 65 deg. instead of a higher temperature. Reams of paper, showing tests and mathematical solutions have been used to prove this. The simple equation which says the heat loss of a room or building is proportional to the difference of the inside temperature and the outside temperature still stands."

"The big problem" says Mr. Fisch, "in the minds of most engineers is not the 65 deg. maximum temperature, but the idea of intermittent heating—heat during the day and shut down during the night. Will there be a saving? One group says there will be no saving or that it will be too small to worry about; the other side says a considerable saving can be appreciated. Could it be, as so often is the case, that both are right?

"Heating systems designed in peace time usually allowed for slight overloads. No thought was given to this extreme intermittent heating. To operate under such war time restrictions, quick re-heating in the morning is necessary; oversize equipment must be available to do this. The system must not only hold its own against heat loss, but must give the entire building a heat gain to establish a 65 deg. temperature. Theoretically, if the building could be brought up to 65 deg. instantly the saving would be equal to all the heat saved during the night. The closer the time of re-heat comes to being instantaneous, the larger the saving. * * *" As for cold end rooms, Mr. Fisch points out that this may be due to bad design or bad maintenance.

All of which seems good sense.

Mr. Klent, Knows Whereof He Speaks

An interesting letter was the one submitted by Wm. W. Klent, Jr., of Kansas City, Mo. He says that he had a number of years' experience as a heating engineer with a gas and electric company. During this time he figured five or six hundred heating estimates in stores, homes and other buildings, and afterwards examined the heating bills. "It is surprising," he writes, "how undependable most people are in quoting their own heating costs * * * The primary theory of heating engineering is that the rate of heat transfer between the air on the two sides of a structure is directly proportional to the difference in temperature between the two sides * * * a ten degree decrease of inside temperature shortens the heating season two weeks or a month. Actually it has been proved that an increase in room temperature of one degree increases the fuel consumption somewhere between 2½ and 3 per cent (in the 60 deg. to 80 deg. F. range). Thus, we may expect a drop in fuel consumption of 25 per cent with this year's 65 deg. temperature as compared to last year's 75 deg.

"Several experiments were run by my company on Our Hero's problem, of the advisability of a reduced temperature during the night. We used recording thermometers and timing devices on automatic forced air gas furnaces during weather temperatures around freezing. We found that if the thermostat was turned down 10 deg. at retiring, no fuel would be required for 4 or 5 hr. as it took the house that long to cool to the lower temperature. It required from 30 min. to an hour to bring the temperature back to normal. Very little fuel was used during the night. If the thermostat was lowered more than 10 deg. too much time was required to bring the temperature back to normal, especially in sub-zero weather. This 10 deg. reduced temperature during the night reduces fuel consumption about 10 per cent."

Mr. Klent closes his letter with various suggestions regarding insulation, one of timing devices on thermostats and finally lets loose with this: "If Our Hero wants a stumper, let him ask, 'How can we convince the ladies that they can live in temperatures of 65 to 70 deg?'"

Personally, we advise Our Hero to lay off that one. He is in deep enough without bringing sex into the discussion.

Difference of Opinion Makes Horse Races

Mark Twain is credited with having said that. Just now we are not concerned with horse racing but we can point to some difference of opinion. Mr. Klent, as has been shown, is very positive that the 65 deg. ruling will save fuel; indeed, his experience proves that it does. Now, however, we have a man whom we shall refer to as T. M. S., since he says his letter is not submitted for the contest and that it is just his opinion. He hails from Wilkes-Barre, Pa.

"I am not a college graduate," says he, "nor an expert in algebra, neither can I boast of being an economist, but I have had a whale of a lot of actual experience in this business of heat, etc., and it seems this ruling is in line with others emanating from Washington, viz., saving razor blades to make a battleship, and setting the clock ahead an hour to save electric current.[1]

"Every engineer knows that it costs more to cool down a boiler, for example, and then build it up to working steam pressure again. Every refrigerating engineer knows that if he shuts off refrigeration on his freezing tanks, cold storage houses or what not, it takes just as much time, coal, and

[1] T. M. S. fails to understand that the change to War Time was made not to save kilowatt-hours but to relieve generating capacity by changing the time of peak loads.

work, to bring them back to normal temperature again.

"It seems a question of saving at the spigot and wasting at the bunghole to yours truly. If we have a house, room or what not, heated to 70 deg., and allow it to cool off to 40, why in heck don't we lose that much heat and have to replace it again? Personally, I know by ACTUAL experience in heating my home for several winters (on Long Island), that it took more coal to let the house cool off at night, and bring it up again to normal heat next day, than it did to keep it warm all the time.

"There is some law and rule for figuring this out. I haven't the time or inclination to go into it. All this is like the Irishman cutting down on his horse's feed. When he got him to where he could live on nothing, he died."

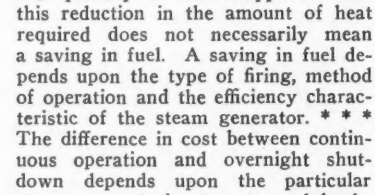
Well, that's that. T. M. S., you see, is very positive. He knows by actual experience that intermittent cooling uses up more fuel, whereas Mr. Klent's experience proves the opposite. It would be interesting to have Mr. Klent's opinion of T. M. S.'s opinion and vice versa.

Mr. Calvert Draws a Diagram

T. M. S. might or might not be convinced by the diagram Fig. 1, submitted with the letter from Julian P. Calvert of Flushing, N. Y., but it is interesting. Says Mr. Calvert, "The Bureau of Mines is correct in its statement that lowering the temperature does effect an appreciable saving in the quantity of heat supplied. But this reduction in the amount of heat required does not necessarily mean a saving in fuel. A saving in fuel depends upon the type of firing, method of operation and the efficiency characteristic of the steam generator. * * * The difference in cost between continuous operation and overnight shutdown depends upon the particular steam generator's start up and banking losses. In the diagram (Fig. 1) the solid lines represent the boiler output, and the dotted lines the desired room temperature (65 deg.). If the shaded areas A and B (banking periods) are greater than C (start up period) there is a saving in fuel by the overnight shutdown. If C is greater than A and B, then it is better to operate continuously."

Comments From California

At least two replies came from California, where we thought nobody knew anything about heat rationing. One of these was from our old friend Bill Maddock of Hermosa Beach, and the other from Homer H. Crider, of Yosemite National Park.



Mr. Calvert's Diagram

Says Bill Maddock, "It takes nerve for a fellow 3000 miles away to try to tell a man in the East how much a 10 deg. reduction in room temperature will amount to on his yearly fuel bill, but here goes.

"First of all, consider this business of starting and stopping, or the common term 'banking.' Those of us in the power game have had this question thrown at us for years. The fundamental reason that any heat has to be added to any heat process over the actual amount needed is on account of heat loss. This heat loss is manifested as radiation, convection, infiltration, etc., all of which are a function of temperature difference. Any given room with a temperature of 100 deg. F. inside[2] and a 0 deg. F. outside will have twice as much heat loss than if it were only 50 deg. F. inside. If a room of 100 deg. F. had its heat supply shut off there would be a rapid reduction at first and then the rate of fall would diminish as the temperature inside got less and less. In any event the total amount of heat loss over a given period of time would be less than if the original 100 deg. F. was maintained. I have always insisted that the extra firing required to reheat is 'mentally magnified' by impatience to where it seems out of balance, and is not substantiated by records. In most instances it will pay to 'bank' rather than to hold.

"As to how much or how little fuel is or can be saved by the 10 deg. reduction can be approximated by calculations. First get a listing of the hourly temperatures below 65 deg. F. and below 75 deg. F. Take the difference between the 65 deg. F. and the actual temperature for each of the hours and total. This gives a figure that could be termed 'degree hours per year.' Do the same for the hours that the temperature is below 75 deg. F. The net saving in fuel should be in direct proportion to the two sums. The regular weather bureau has this data but may decline to give it out as a War precaution, and, if so, here is a less difficult and less accurate method.

"The American Gas Association has adopted as standard a Degree Day. A degree day is a day in which the mean temperature is one degree less than 65 deg. F. My handbook gives New York as having a heating index number of 5290 degree days per year. Also it shows that all of these days fall within the months of October to May or in about 240 days. Then it may be assumed that the mean temperature for those days is

$$5290 = 240\ (65 - T)$$

From which T is equal to about 43 F. Now if the figure of 65 is replaced by 75 deg. F. and the number of days held the same

$(75 - 43) \times 240 = 7800$ degree days.

Now from this relation it can be shown that the fuel required to hold a room at 65 would be

$\frac{5290}{7800}$ or 68 per cent of what it would be if the room were held at 75 F. The saving would actually or probably be more than this because the heating season would be shorter, the banking hours longer, and also because the rooms would be less comfortable resulting in earlier retirement.

"This is all in theory. It is my personal opinion that a hospital would be a poor place to experiment along this line. The patients confined do not have the same temperature requirements as healthy people, and the attending personnel are subject to enough exposure of 'bugs' without adding the discomfort of cold. From the few hospitals that I have had a chance to observe, it has been noted that the laundries and kitchens take as much steam as the heating systems, and that in some cases even all of this steam had first passed through a generator prime mover for electric power supply."

So much for Bill Maddock's analysis of the question. Mr. Crider, who dwells in Yosemite National Park (lucky guy) feels the problem is divided into two parts: first, that which pertains to end rooms and second, that concerned with the possible saving to be made by lowering the temperature at night.

The end rooms, he says, should be considered from a corrective angle. The cold end rooms imply a fault in the heating system which should be corrected.

"The second part," he points out, "might be a matter of facts and figures as an air-conditioning problem of which heating is one phase. As such, in terms of resistance, conductivity and specific heat of various building materials, some rather interesting facts are available. Not the least important of the factors involved are those of usage, opening of doors and window leakage, which usually comes under the term of exfiltration. At any rate, when all losses are considered, if the heating system does not supply heat during the period in which a building is reducing from a higher to a lower temperature point which is to be maintained, there is no saving. The reason is that the building itself is supplying the heat known as specific heat. This is replaced in exact amount during the raising part of the cycle. There is a time lag between raising of the air temperature and replacement of the specific heat in the walls; but any such heat used is again replaced in the course of the cycle.

On the other hand, if the pre-determined lower level is reached prior to the time set for the temperature to be raised again and if the heating facilities are used, then the difference in the amount of fuel consumed and what might be consumed if the higher temperature was being maintained, is what is actually saved. The extra fuel

[2]Only a Californian would use 100 deg. for an example. Ed.

used in again regaining the higher point is not counted because that balances with what was saved by use of the specific heat.

It is possible to compute from air conditioning specifications the heat load of any building under any conditions. Considering the human usage load as static and the inside-outside differential as a variable, it would be practical to set up a heat load schedule for each five degrees outside temperature. To do so in this article would not be possible; but it would be possible to select an example from such a schedule and illustrate the saving made by dropping the temperature during a part of a 24 hr. period.

The example which Mr. Crider presented proves his point but for lack of space it is not reproduced here.

A Little Education in Heat Laws Would Help

Eugene R. Ambrose, Heating, Ventilation and Air Conditioning Engineer at the American Gas & Electric Co. in New York feels that people should be educated in how to reduce heat losses. Quoting from his letter: "In all the rules (regarding the 65 deg. ruling) which I have seen, nothing has been said on where or how this 65 deg. temperature is to be measured; whether in a double exposure, single exposure, or internal room, whether on the floor, at the ceiling, or elsewhere.

If a lower temperature is maintained within an enclosure, there is little doubt that fuel saving would result, in proportion to the temperature reduction. However, the chief difficulty is the maintaining of this predetermined temperature. A majority of the heating systems now installed are not zoned and are manually operated, which usually results in wide temperature fluctuations. In order to maintain a uniform temperature throughout a house, building, etc., it is almost necessary for the system to be properly zoned and have automatic controls. The cost of the necessary alterations to existing systems to obtain this uniform temperature is usually prohibitive, consequently most of the systems are operated so that the temperature fluctuation will never fall below that required for minimum comfort. This type of regulation results in a higher average temperature.

Quite a few articles have appeared by medical men stating that 65 deg. F. is satisfactory from a health standpoint. To my knowledge no conclusive tests have ever been made to definitely prove this point and furthermore it would be next to impossible to obtain reliable test data since too many variables are involved. The type of individual (thin, fat, active or inactive), type of clothing, room drafts, surrounding wall temperatures, amount of infiltration, and window location are just a few of the influencing factors which must be considered.

If the 65 deg. F. ruling is not the answer, then what is the correct approach to reduce fuel consumption? To me the better and more sensible solution to the problem would be to educate the people on how to reduce the heat loss (making available necessary funds for improvement) and how to provide proper maintenance of the system.

A recent article appeared in the University of Illinois Engineering Experiment Station Circular 26 showing what heat loss reductions can be made in a typical 3-story house having a heat loss of approximately 150,000 B.t.u./hr. with an 80 deg. F. temperature difference.

1. Window weather-stripping results in a reduction of approximately 10%
2. 2 in. roof insulation results in a reduction of approximately....13%
3. 2 in. wall insulation results in a reduction of approximately....17%
4. Installation of storm sash results in a reduction of approximately 31%

The largest single reduction in heat loss is the storm sash windows. If items 1, 2, 3 and 4 are all carried out, a 61 per cent reduction in heat loss would result. The above mentioned article also shows that if 3½ in. insulation is used on roof and walls, together with storm sash, a 66.1 per cent reduction could be made.

Definitely, Yes

John W. Hogg of E. I. du Pont de Nemours & Co., Philadelphia, is very definite. "The answer to your question," he says "is yes. . . . Many complicated formulas are available on heating but I assume you want a straightforward non-technical explanation.

"The total heat which must be supplied by a heating plant is equal to the heat lost by transmission through the various materials which form the enclosure, the heat necessary to warm infiltration air and if mechanical ventilation is used, the necessary heat to warm this air.

"Since the average residence does not have mechanical ventilation, two factors are involved—transmission and infiltration.

"Transmission: In a given structure or enclosure the rate of heat transmission from the inside to the outside is substantially proportional to the difference in temperature between the inside and the outside. (For instance, for an outside temperature of 30 deg. and an inside temperature of 65 deg. compared with the same outside temperature and an inside temperature of 75 deg. there will be only 100 (65—30) ÷ (75 — 30) = 77.8 per cent as much heat lost to the outside at an inside temperature of 65 deg. as with a temperature of 75 deg.).

"Infiltration: The amount of infiltration air will be more (Is usually less) in an enclosure maintained at a temperature of 65 deg. than at a higher temperature. Accordingly the same amount of air (from infiltration) will require heating from the outside to the inside temperature. Hence, less fuel will be required to heat it if it is raised from outside temperature to 65 deg. than if raised from outside temperature to one above 65 deg. (For instance, if the outside temperature is 20 deg. and the two inside temperatures to be compared are 65 deg. and 70 deg. respectively, the heat to be supplied in the first case compared to the latter will only be 100 (65—20) — (70—20) = 90.0 per cent as much, specific heats and quantities being the same in each case.)

How Far is it to Chicago?

Our old friend Harold D. Brown of Lombard, Illinois, who has participated in these contests before says the question is very much like asking, "How far is it to Chicago?" The answer depends on where you are when you ask the question. How much fuel will be saved depends upon what temperatures have been maintained in the past and upon what the outside temperatures are. In Chicago, he claims ½ or more of the fuel would be saved by lowering the inside temperature from 75 or 80 deg. to 65 deg. Quoting from his letter, "One office building in Chicago saved approximately 1/3 of the steam used for heating by trying to keep the offices at 75 deg. instead of allowing part of them to become overheated so that the tenants opened the windows to cool off. This is not a guess; records were kept of the amount of steam used per 1000 cu. ft. of space per degree day per day.

"Before the heating system was put in first class condition and steam pressure controlled to give the proper amount of heat, the steam consumption was 0.9 lb. to 1.0 lb. per 1000 cu. ft. per degree day per day. After the steam was more closely controlled the consumption was 0.6 lb. or less.

"Another plant made a saving of from 10 to 20 per cent in their fuel by removing some of the water pockets from the steam lines so that it was not necessary to overheat part of the buildings in order that other parts could have enough heat. If there are doubting Thomases the actual figures can be had to prove this statement.

"On both of these jobs a much larger saving could be made by reducing the inside temperature to 65 deg.

"All of the experiments carried on in space heating or cooling proves that the heat loss or heat gain increases or decreases as the temperature difference between the outside and inside increases or decreases as the temperature difference between outside and inside increases or decreases. . . . I believe the reason that many people believe that there would not be any saving in lowering the temperature to 65 deg. is because they do not take into consideration the many factors which enter into building heating such as hours of sunshine, wind velocity, amount of heat in outside air, air motion in the occupied space and the effect of wall temperature. . . . Shutting down at night should show a savings but there are many factors to consider such as length of time allowed for warming up when the heat is put on

again, boiler efficiencies during regular operation and during the warm up period, etc. . . . I have not used theory to prove what I have said because if Hero want theory many examples are worked out in the A.S.H.&V.E. Guide."

Joseph M. Chambliss of Buffalo, N. Y., thinks very much as Mr. Brown does about the problem. He also mentions the factors of wind velocity, sunlight, efficiency of heating system, etc. . . . As to lowering the temperature at night, he points out an investigation made by the N.D.H.A. indicated that a definite saving usually can be made in heating a building 11 to 16 hr. daily as against 17 to 24 hr.

Stanley Eriksen pointed out in his letter that in working with high pressure boilers, when the pressure was dropped from 165 lb. to 125 lb. with the load taken off, the consumption of coal was more than cut in half. It was also possible to raise the pressure again in rather a short time.

Edward P. Stahl was quite emphatic in regard to the question of humidity. "Humidity bears a direct relation to bodily comfort and fuel saving. Little is understood about this subject.

"Most of our homes and public buildings are overheated with excessively dry air in the winter time. The air is fairly 'baked.' In most homes heated to 70 deg. F., and higher, in cold weather, the humidity is generally less than 25 per cent, which is drier than any natural climate in the world, even drier than in a lot of deserts. Since most air in homes and public buildings is dry, it is necessary to counteract or offset the drying out of the air by evaporating moisture. This must be done artificially.

"Scientific investigations have shown that temperatures ranging from 66 to 68 deg. F. with fair humidity, say about 50 per cent, is considered the most healthful. People living in these temperatures will find themselves less annoyed by dry irritable skin, irritations of the throat and bronchial trouble. They are easier to live with. Air heated to 66 to 68 deg. F. and a relative humidity of 60 to 70 feels warmer than a temperature of 70-75 deg. F., and a relative humidity of 20 per cent. This is a good thing to remember these days when everyone is trying to save fuel and still be comfortable.

"A relative humidity from 45 per cent to 50 per cent is found most nearly ideal for homes and business places. The question arises, what is meant by a relative humidity of 50 per cent? This means that the air in the room contains 50 per cent of the amount of moisture it might hold at a given temperature if it were saturated, moisture in the form of vapor, not visible steam or fog.

"The question naturally arises, How much water must be evaporated daily in an average seven or eight room house in order to keep the humidity anywhere near the ideal of 50 per cent when the air is heated from below freezing to 68 deg. F. or higher? The answer is 10 to 12 gal.—better still, 20 gal. Ordinary humidifiers or cans fastened to heaters that evaporate 1 or 2 gal. a day are of little or no use. Improvised cans or tanks with wicks can be fastened to the registers or radiators which will evaporate the proper amount of moisture. Standard humidifiers can also be secured on the open market that will accomplish this.

"Recently a survey was made in Chicago by physicians and health officials with the idea that if school children were educated to pursue their activities in cooler rooms they, in turn, would educate their parents along the same line. After thorough investigation and experimentation, it was found that by a very little adjustment of the building conditions, warm open air rooms could be secured and children thrived just as well in temperatures from 60 to 66 deg. F., when sufficient humidity was supplied as in warmer air, and no extra clothing would be needed. It has been demonstrated that children do better in a temperature about 66 deg. F. than in higher temperatures.

"Everybody who will warm up to a cooler theory will be healthier and will save fuel.

"Don't forget the way our ancestors used to get along with little heat. They did all right with a fireplace and later with wood and coal stoves and it was plenty colder than 65 deg. F. in most of their homes."

In a closing comment from J. M. Hartman who won duplicate third prize, he points out "that an indoor temperature of 65 deg. may not be uncomfortable even to the ladies if there is no thermometer to observe, providing there is sufficient humidity. But try to maintain that humidity."

LETTERS AND COMMENTS

Comments on Humidity Control

I HAVE read with interest the articles by F. S. Graham in the October and December, 1942 issues of POWER PLANT ENGINEERING and find them very instructive. Since the subject of humidity control as related to the preservation of foods in refrigerated rooms is one of great importance, the methods employed to obtain satisfactory humidity control are of equal importance.

The author has clearly shown how great quantities of food stuffs may be wasted by improper humidity in the storage rooms, especially as regards the dehydrating effect of low humidities on meats, etc. The experience of many engineers and merchants will substantiate Mr. Graham's statements in this respect.

Several statements made by Mr. Graham should, in my opinion, be subjected to analysis based on the methods and the results being obtained by the application of the most modern, present-day practices in preserving foods by refrigeration.

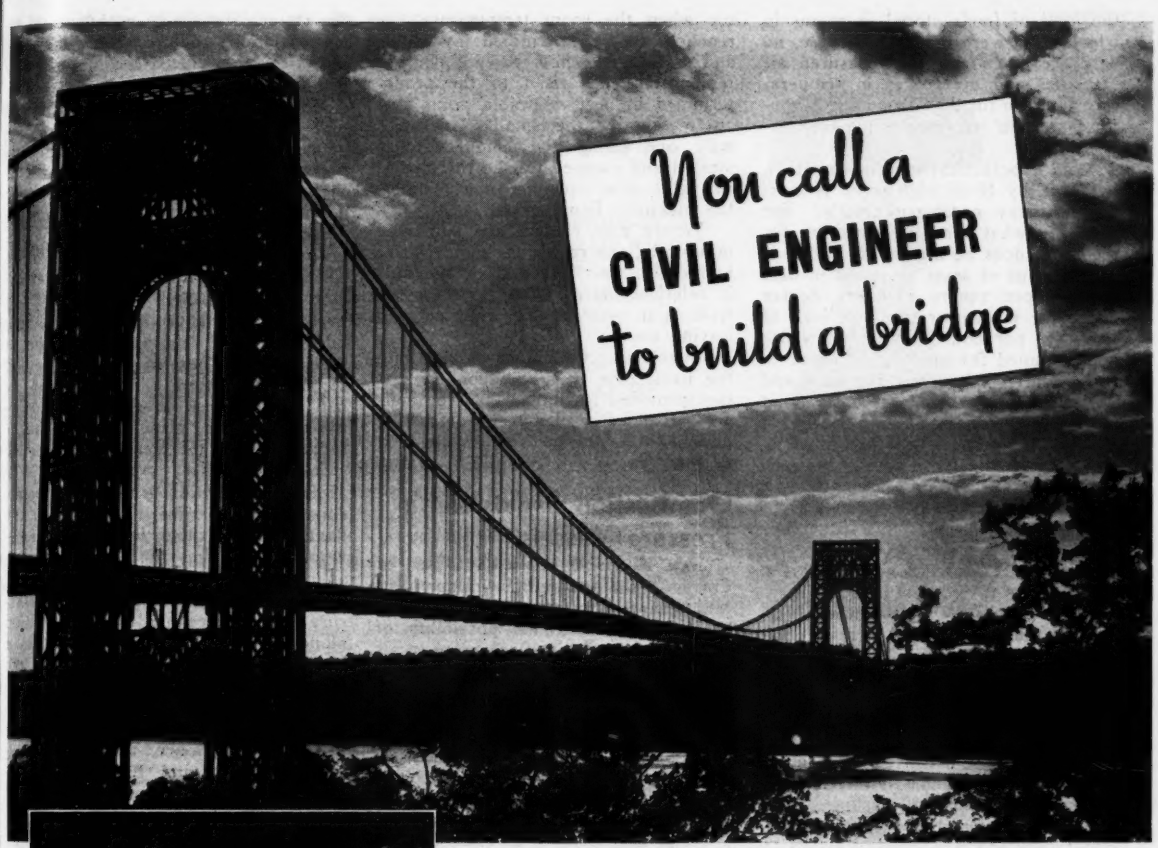
First, I would like to refer to the author's statement in the October issue that the amount of heat to be removed from foods placed in the refrigerator is from two sources—"the heat in the food when placed in the refrigerator and the chemical heat produced by decomposition."

When food decomposes, decomposition is the result of decay and physical breakdown due to bacterial action. If such action is of sufficient magnitude to liberate even a small amount of heat as mentioned by the author, it would appear that spoilage would occur to a degree that would render the food dangerous and unsuitable for human consumption. There often occurs heat liberation from certain foods in refrigerated storages, particularly those carried above 32 deg. F. that results from the continued ripening or living processes for a period after storage. This is known as vital heat the magnitude of which is dependent upon the degrees of ripening when placed in storage and the temperature of the food when first stored.

Unfortunately, the humidity condition that approaches the ideal from standpoint of dehydration, is not ideal as regards bacterial growth. High humidity, in refrigerated meat storage rooms for example, greatly reduces loss in weight due to dehydration, but it also increases greatly bacterial growth. To hold losses in weight to a minimum the humidity must be high and yet were we to attempt to eliminate all shrinkage, due to loss in liquid content of meat, it would, as shown by the investigations of R. Heiss of Karlsrue laboratory, require that, the water vapor in the air must equal the saturated vapor pressure of the water held in solution in the meat surface which he found to be very nearly that of pure water and that a very high humidity of from 92.2 to 99.4 per cent in the surrounding air would be required to completely prevent evaporation. This would of course be at the expense of high bacteria growth.

H. Walter has found that bacteria will not multiply at humidities less than 96 per cent while Dr. Ewell has found that the air immediately in contact with meat has always a higher moisture content than does the general air of the refrigerated room which he states explains the growth of bacteria upon meat in rooms where the humidity is much below 96 per cent.

Now, referring to Mr. Graham's discussion of the methods advocated by him for the control of humidity, the arguments which he advocates have not included any actual operating data such for example as dry bulb temperature readings and humidity values for the various foods stored. neither does he supply information on



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the kind of foods stored in rooms in which tests were made. Likewise, no data are given showing measured air velocities and differences in temperature between the air leaving the evaporators and air returning to the evaporators.

The hypothetical case of the 10 ft. by 10 ft. by 10 ft. high room is lacking in many necessary details. For example, what kind of insulation for the room does he assume and what is the K value of same as stated in heat transfer per square foot per degree difference in temperature per inch of thickness per hour? What allowance was assumed for opening of doors to this room? What was the kind and weight of foods stored per day? What was the evaporating temperature in the cooling coil? What was the assumed heat transfer per hour between the refrigerant and the circulating air per square foot of evaporating or cooling surface? Was this value constant winter and summer? What was the difference in temperature between the refrigerant and that of the air entering the coil? What was the difference in temperature of the refrigerant and that of the air leaving same? What became of the water represented, either as water or frost on the evaporator, and did the water resulting from defrosting operations drain out-doors or on the floor of the hypothetical room to be again picked up by the air?

In the absence of assumed data such as mentioned above, it is difficult to see how the simple illustration of the 10 by 10 by 10 room carries much conclusive weight as to just what would happen in such a refrigerated room.

It has become the practice in recent years for engineers to give more and more consideration to the subject of dehydration of foods in storage and this has led to a decided change in the design of room evaporators which in turn has, to a very pronounced extent, prevented dehydration.

This has been accomplished, in many instances, by providing liberal cooling surface in the evaporators. This permits the carrying of higher suction pressures and therefore higher evaporating temperatures, which means that the cooling load may be handled with a minimum "split" or difference between the surface temperature of the evaporator and the temperature of the air passing over the evaporators.

It is apparent that the smaller the temperature drop between the entering and leaving air at the evaporator, the less the drying effect or moisture removal from it. Constant evaporating pressure is maintained in the evaporator by constant pressure valves, sometimes called back-pressure valves, which may be set to maintain any desired evaporating pressure and temperature regardless of the lower suction pressure in the main suction line to the compressor. Such valves may be used on any type of coil evaporator or unit cooler. Thermostatically controlled, magnetic liquid valves stop the flow of refrigerant to the evaporator when the room temperature has reached the predetermined low point and restores the flow when the room temperature has risen to the predetermined highest allowable point.

In case of the small plant with only one room, the compressor is started and stopped by the thermostatic valve with opening or closing of the magnetic liquid valve.

Where unit coolers are employed in installations requiring high relative humidities, the C. F. M. of the fans is relatively large thus preventing a wide split between the entering and leaving air.

In selecting the blower or installing the usual pipe coils, the cooling surface provided is ample when the coils are frosted or between defrosting periods.

Atlanta, Ga. C. T. BAKER

Combustion Explosions in Pressure Vessels

SAM HANSEN'S article, The Part of Correct Lubrication in Equipment Maintenance, appearing in the September issue mentions the possibility of combustion explosions occurring in air compressor systems as a result of excessive compressor lubrication.

Combustion explosions are not limited to compressed air systems or receivers alone, but may also occur when vessels used for processing or cooking are emptied of their contents by means of compressed air. Often, news items in giving an account of an explosion will attribute the accident to over-pressure and failure of the protective devices. Subsequent investigation by experts shows that actually a combustion explosion or detonation took place.

Frequently, processing vessels contain gaseous hydrocarbons and deposits of carbon as a result of the reaction between the material being processed and the reagents used. Steam coils or jackets may be used to hasten the processing, and when used the temperature conditions are often ideal for rapid oxidation developing into spontaneous combustion, the oxygen of course being obtained from the air being used to force the contents from the vessel.

Spontaneous combustion is due to the adsorption of oxygen by porous combustible substances. The adsorption generates heat and if the oxidation is sufficiently rapid the temperature necessary for self-ignition is soon reached and the substance starts to burn. Any heat supplied from an outside source such as steam coils or jackets would accelerate the oxidation. Once the deposit has reached a temperature to cause self-ignition the mixture of air and gaseous hydrocarbons would start to burn.

Gaseous explosions are reputedly said to pass through certain phases commencing with relatively slow flame diffusion or propagation, which accelerates rapidly culminating in a phase of maximum speed and intensity known as a detonation. Here again, the heating effect of steam coils or jackets, or the residual heat left in the vessel or its insulation would assist in accelerating the extremely rapid oxidation leading up to a detonation.

There is some phenomena connected with detonations that is difficult to explain (at least by me) in that the pressure generated by the explosion of the combustible mixture is apparently not evenly distributed throughout the vessel. Both heads may be blown out, or one head blown out and the other considerably distorted, but in either case leaving the shell intact.

Explosions have occurred in pipe lines that have ruptured the pipe at several points but leaving intervening sections untouched. This cannot be laid to weakness or defects as often the failure takes place in the stronger section leaving the weaker or defective sections unharmed.

One explanation is that as the gaseous mixture ignites it burns with the flame traveling along the length of the vessel. Preceding the flame there is an increase in temperature accompanied by an increase in pressure. This pressure wave preceding the combustion along the length of the vessel has a cumulative effect and compresses the unburned gas to such a degree that the temperature rises sufficiently to cause the ignition of the remaining mixture all at once, thereby causing the detonation and blowing off the head that the pressure wave was approaching.

A so-called retonation or back surge of the explosion wave then is believed to pass through the shell leaving it intact, but the directional effect of the explosion wave blows off or distorts the head on the opposite end of the vessel from where the detonation took place.

Of course the different steps or phases outlined all occur with extreme rapidity and are all over before the conventional safety valve or pressure gage can operate or indicate excess pressure, due to the inertia of their parts. The only possible means that can relieve the pressures attained so swiftly by a detonation or combustion explosion in a vessel would be a frangible or rupturing disc, or possibly a water seal. The latter would probably be limited to use where the operating pressure was very low.

The ease with which vessels may be quickly emptied of their contents by means of compressed air has appealed to many engineers and is often used when the engineer has no realization of the hazards involved. If air is being used for such a purpose it would be worth the engineer's time and efforts to do a little investigating to determine if the material or substance being handled, or its residue has any combustible qualities. If so, steam may often be used as an evacuating medium. If steam cannot be used because of difficulty in reclaiming the material or substance, it would be better to draw-off by gravity than chance a combustion explosion.

Melrose, Mass. O. W. MALARKEY

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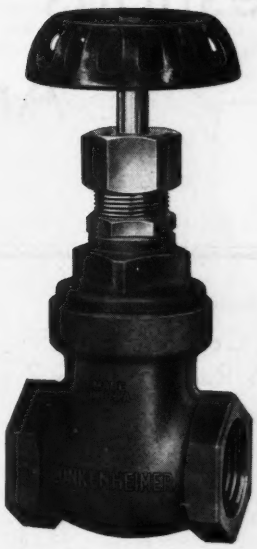

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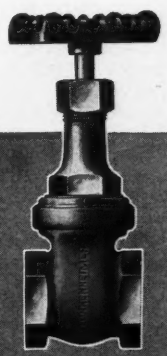

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Questions And Answers

Question No. 221

Can He Connect 220-v. Motor to Run on 110 v.?

CAN YOU give me any information on re-connecting a 220-v. d.c. motor for use on 110 v. so it will run at its normal rated speed and horsepower? In these days of limited equipment, we often are able to purchase the 220-v. d.c. equipment, but as our current is 110 v. we can only get half the capacity of the motor.
Waukesha, Wis. C. W. W.

Question No. 222

How Prevent Fuses from Blowing?

ALL MY 220-v. power fuses, clear back to and including the main board, are 30 amp. An overload will frequently blow the fuses on the main board, putting all machines out of operation. We have renewable fuses.

Would it do any harm if I put in *two* 30-amp. links in each of the main board fuses? All machines are protected individually by 30-amp. fuses. If I did put in two links, how much would that increase the amperage? Twice, or more?
Peterborough, N. H. A. H. P.

Question No. 223

Why Does Total Heat Decrease Above 450 PSI?

IS THERE any simple explanation of the fact that the total heat of saturated steam begins to fall off as the pressure increases beyond 450 psi. absolute? (Keenan & Keyes Table gives the same maximum value for 420 to 470 incl.—Ed.) Can this be explained by saying that the specific heat of steam becomes less at high pressures? I should appreciate it if you can explain this without too many technical terms.
St. Louis, Mo. A. W. C.

Question No. 224

Will He Save Coal by Watching Steam Gages?

I HAVE no means of finding out the following so I am asking you to help me. I have charge of a low-pressure heating plant and I would like to know whether I could effect a saving in coal by more careful attention to the steam pressure carried. If I can heat the building with 20 tons of coal a month when I do not have any pressure on the system as indicated by the steam gage but read a temperature of 212 deg. on a thermometer in the steam line, how much more coal would I burn if I kept 5 lb. pressure on the system? This may sound impossible, but it is actually a fact that I heat all the radiators in the building with no complaints, when there is no indication of any steam pressure on two steam gages located at widely separated points on the system. Of course, they may not read correctly, but I know that the thermometer is correct as I tested it in boiling water and it read 212 deg. I am wondering whether it would make enough difference in the coal bill to keep a close watch on this.
Cleveland, O. C. C. McILYAR

THE AMOUNT of coal used in heating your building is not so much dependent upon the steam pressure carried in the system as it is upon the quantity of steam used in heating the building. Given a certain amount of steam used, the amount of fuel used will be higher for a pressure of 5 lb. than for 0 lb. but actually the difference will be extremely slight.

The total heat of steam at 14.7 lb. abs., that is 0 lb. gage as given in steam tables, is 1150.4 B.t.u. per lb., whereas at 20 lb. abs., or 5 lb. gage, the B.t.u. content of steam is 1156.2. In other words, steam at 5 lb. pressure contains 5.8 B.t.u. per lb. more heat than steam at atmospheric pressure, that is at 0 lb. gage.

With an average bituminous coal of, say, 12,000 B. t. u. per lb., and assuming a boiler efficiency of, say, 70 per cent, the amount of extra coal needed to make a pound of steam at 5 lb. as compared to that needed to make a pound of steam at 0 lb. will be

$$\frac{5.8}{12{,}000 \times 7} = .00069 \text{ lb.}$$

So, you see, even with an evaporation of, say, 1000 lb. of steam per hr. the additional fuel required would be only $1000 \times .00069$ or .69 lb. of coal per hr. With 10,000 lb. of steam per hr., the increase would be 6.9 lb. of coal per hr.

If, as you say in your letter, you can operate your system satisfactorily by keeping the pressure at 0 lb. gage and keep all the radiators warm, it is quite certain that you are using enough pressure in your system. Unless you receive complaints there is no reason for using any higher pressure. Still, as I have pointed out, if the pressure does go up a few pounds, the additional coal required will be relatively small and I do not think that you need make any great effort to attempt to keep the pressure exactly at 0 lb.

So far as your pressure gages are concerned, they may or may not be accurate, but if, as you say, you have tested your thermometer you can accept its reading with assurance that it is indicating the correct pressure. At 5 lb. pressure the thermometer would indicate a temperature of 228 deg. F. Therefore, if on your system you get a consistent reading of 212 deg., it is quite certain that the steam pressure in the system is very close to 0 deg.

Answer 186

He Wants Air Filters to Last Longer

ON p. 100 of the July issue, W. M. was somewhat discouraged over the high cost of upkeep of his air filters. He had 32 spun glass air filters which had to be discarded after being vacuumed 3 or 4 times. At a cost of $1 each the replacement cost runs about $130 per yr. for material not counting labor. Because of this, he wanted to know whether it was feasible to arrange some kind of a prefilter ahead of the glass units to catch some of the dirt and thus relieve the glass units of some of the load and so increase their life.

George Diechmann now comes forth with an answer to W.M.'s problem. As he points out there is more than one kind of filter available and the kind to use depends upon the use that it is put to. He, therefore, shows how to build two kinds.

Make Them Yourself from Things Easily at Hand

THERE ARE two kinds of filters. One type is designed especially for use in the suction lines going to air compressors and the other kind is more suited for service in connection with air conditioning systems. The kind for air

STICKING YOUR NECK OUT

ALL Q. & A. Readers are reminded again of this comment on page 85, August 1942 issue, P. E. & E., by Editor Morris, now Capt. Morris, U. S. A.: "We realize that many questions are incomplete and that such questions cannot be answered fully without assuming certain data or conditions that may not be given. This is always permissible. After all, the question states a problem that is bothering some engineer. A definite answer is not nearly so important to him as is the method of approach. Your neck may get stepped on—that's the price one must pay for stepping out of the ranks to lead rather than to follow blindly."—R. H. M.

PACKING

Edward processed rings of EValpak (graphited asbestos, wire inserted type) for severe pressure and temperature service.

STEMS

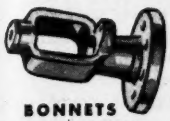
Heat treated and ground EValloy, Edward's highly heat resistant stainless steel, with Acme form threads.

DISKS

Carbon-molybdenum alloy steel with heavy layer of ground and lapped Stellite. Designed to prevent spinning in service.

HANDWHEELS

Strong, malleable iron, with over-size dimensions and knobbed for easy grip and quick operation.

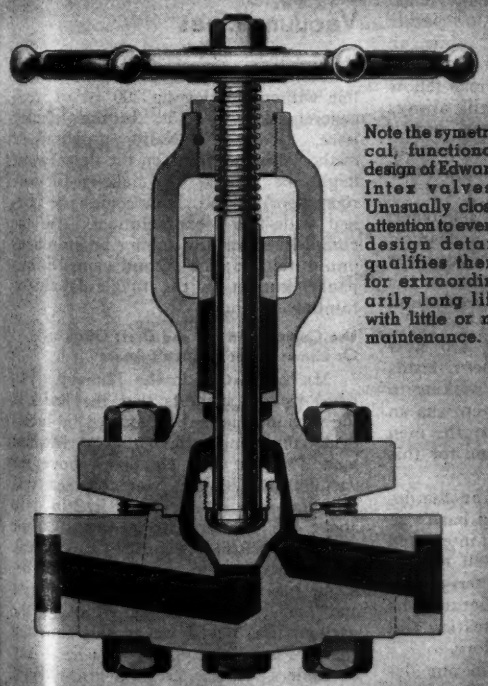


BONNETS

Carbon-molybdenum steel with replaceable bronze yoke bushing. Extra deep stuffing box and condensing chamber lengthens packing life.

BODIES

Weldable carbon-molybdenum steel with flanged, screwed or socket welding ends. Integral, erosion-resistant Stellite seat with wide contact face.



Note the symetrical, functional design of Edward Intex valves. Unusually close attention to every design detail qualifies them for extraordinarily long life with little or no maintenance.

EDWARD INTEX* VALVES FOR TOUGH WAR JOBS

If you're looking for a valve that will stand up on the *really tough* war jobs where piping systems are operating at temperature and pressure extremes, here's the answer.

Edward Intex globe stop valves, built for service to 1500 lb at 950 F, include such wear-fighting features as integral seats of Stellite, balanced disks which are also generously faced with erosion-resistant Stellite, and carefully contoured bodies that eliminate distortion in heating and cooling.

You gain this way, too ... Because Edward Intex valves are so widely used and are being manufactured in production-run quantities, delivery schedules are better than you usually expect these days. If you want the whole story on Edward Intex valves, write today for Catalog 12-G5.

* *Integral Seat Valves of Extra Value*

THE EDWARD VALVE & MFG. CO., INC.

220 WEST 144th STREET

EAST CHICAGO, INDIANA

EDWARD *Steel* CAST AND FORGED VALVES

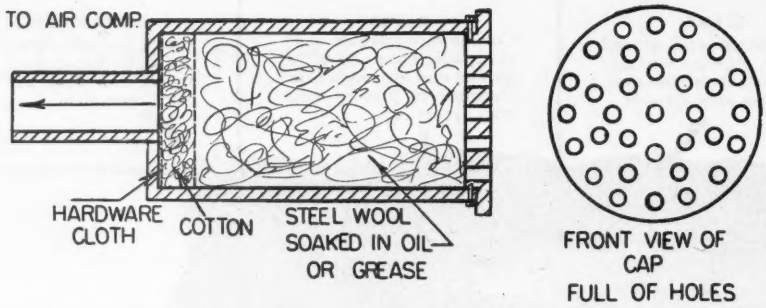


Fig. 1. Air filter which can be constructed of tin or pipe and attached to the suction lines

compressors are usually attached to the end of the suction lines and as shown in Fig. 1 can easily be made from tin or pipe. If the air filters W.M. is concerned with are used in air conditioning systems, however, he can construct

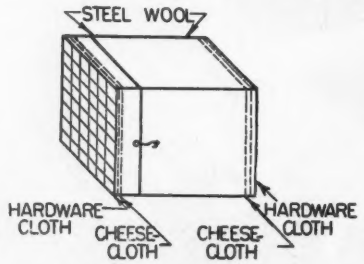


Fig. 2. This air filter can be used in air conditioning systems

the type shown in Fig. 2, out of sheet metal, hardware cloth and steel wool. When these units become dirty, they can be opened up, the steel wool taken out soaked or boiled out in hot water and then re-oiled before replacing.

New Orleans, La. GEORGE DEICHMANN
Falstaff Brew Plant No. 4

Answer 191

Help on Training Operators

THERE HAS been very little response to the question asked by D.J.C., of Pittsburgh, Pa. on p. 98 of the September issue in regard to what is being done by other companies in the training of power plant help in these times. Apparently other companies are having their troubles in this respect and there is little that they can say. We are, however, pleased to present one answer to D.J.C.'s. question by Mr. Mullen.

He Is Glad to See This Question Asked

This is one question that I am glad to see asked and it is a shame to think that it takes a war to get some action on the training of power plant personnel. This should be our subject in all plants even if we have to hire through some engineer's local, such as the N.A.P.E., which has local associations in all the main cities.

All men who take this type of work for a livelihood are not doing justice to their bosses, their position or to themselves when they do not try to learn all that is possible. At the present time many men are working in power plants who have not had very much experience in the field. These men are taking the place of the younger men and many of the older men who are in the service either to do the fighting for Uncle Sam or to do bigger and better jobs for the same Uncle.

For the training of these new employes it is only fitting and proper to educate these men as much as possible. A person who likes his job or trade does not have to be told to learn all he can about it; he will seek the information in several ways, such as visiting other power plants, power shows, and other exhibits of a mechanical nature.

In planning training of operators it is well to get the opinion of all the operators in each particular department and ask if they care to go to a night school, or form an educational class in the plant, or have a separate class in each department. While an interesting program on all phases of equipment is what the ambitious fellow wants, a certain number will always fall away from these classes, but if some kind of a bonus is paid instead of prizes, it will keep competition among all the class.

Points for interesting sketches, articles, suggestions or mechanical oddities found in the plant or any other plant, will also keep the men on the alert for better ways to get production increased and work finished.

In the company that I am now employed by, the department heads had to start a class for men wishing to learn mechanics. The first step was an aptitude test to show whether the men had the mechanical inclination for this type of work.

As I am in the power plant, the department head of this section hasn't so much as tried to get the men interested in their work and become self reliant, but a lot of the blame can be put on the chief engineer's shoulders because he doesn't have much of an education and doesn't care to learn anymore.

The last man to come in our department is about 60 yr. old and he says his days for studying are over; the third man never worked on high-pressure boilers or refrigeration and he does sales work on the side, another one of the type that doesn't need to learn because he's too busy making commissions somewhere else.

As we started out to mention ways of educating operating personnel there are many ways of obtaining this information for the plant men as I mentioned earlier in this letter; a good idea would be to get the cooperation from the chief engineer and superintendent from a nearby plant or plants and compare the experience and knowledge of the operating men.

The chief engineer could submit sketches of his equipment with inserted mistakes, mistakes that all the men of each particular crew should be familiar with. From time to time more difficult errors could be inserted so as to stir up some competitive action between the men. In this way, through the combined criticisms and ideas, all possible angles of correcting the errors will be covered. Thus providing each individual operating man with a working solution to the problems in question.

So if the men will seek information from each other in this manner, whether it is in your own plant or in some other plant, everyone should profit by each other's experience and knowledge. Let us help the ones that want to be helped and kind of coax the stragglers along; and make our saying "Praise the Lord, and pass the information."

Philadelphia, Pa. WM. T. MULLEN

Answer 193

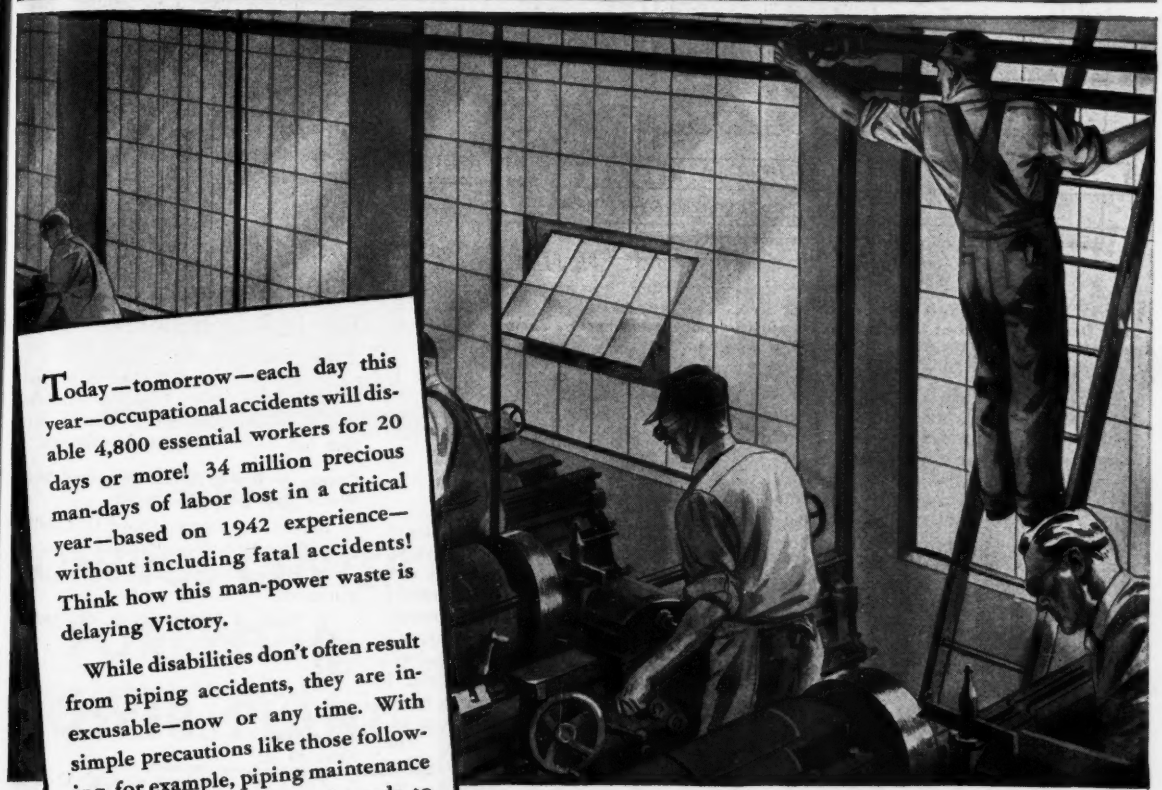
Locating Leaks in Buried Vacuum Lines

IN THE October issue, I. D. asked how to locate leaks in an underground vacuum line without tearing up 200 ft. of good concrete floor over it. In the January issue, George McNally proposed a method using sawdust on the floor—what might be termed the face-on-the-barroom-floor method. Now comes Joe Darnell with two more solutions: one the compressed air and tubing or stomach-pump method; the second using litmus paper, known as the razzle-dazzle or rainbow method.

Use Compressed Air and Draft Gage Or Litmus Paper to Locate Leaks

MR. MCNALLY, in the January, 1943, issue, p. 106, suggests that the leaks in the vacuum line may be located by measuring the temperature of wet sawdust placed on the concrete floor above the vacuum line. When you consider that this floor is 5 in. thick, and is 2 to 3 ft. above the vacuum line, it seems to me that this scheme is rather impractical. The author of the question did not describe the material between the concrete and the terra cotta pipe enclosing the vacuum line, but if we assume that the concrete is laid on gravel with hard clay or cinders below, there is a grave doubt that the steam and water which Mr. McNally proposes to inject, respectively, into the vacuum line and surrounding tile, will penetrate the fill between the tile pipe and the concrete.

4800 WORKERS WILL BE HURT TODAY



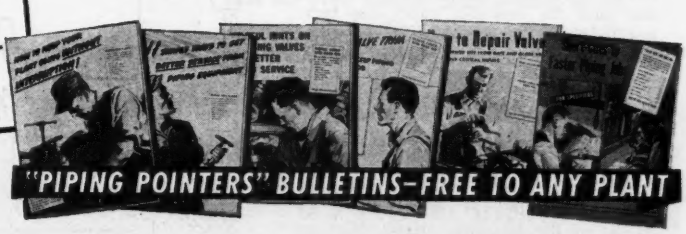
Today—tomorrow—each day this year—occupational accidents will disable 4,800 essential workers for 20 days or more! 34 million precious man-days of labor lost in a critical year—based on 1942 experience—without including fatal accidents! Think how this man-power waste is delaying Victory.

While disabilities don't often result from piping accidents, they are inexcusable—now or any time. With simple precautions like those following, for example, piping maintenance men can help lessen the hazards to American workers now when they're most needed on the job.

SAFETY HINTS FOR PIPING MEN

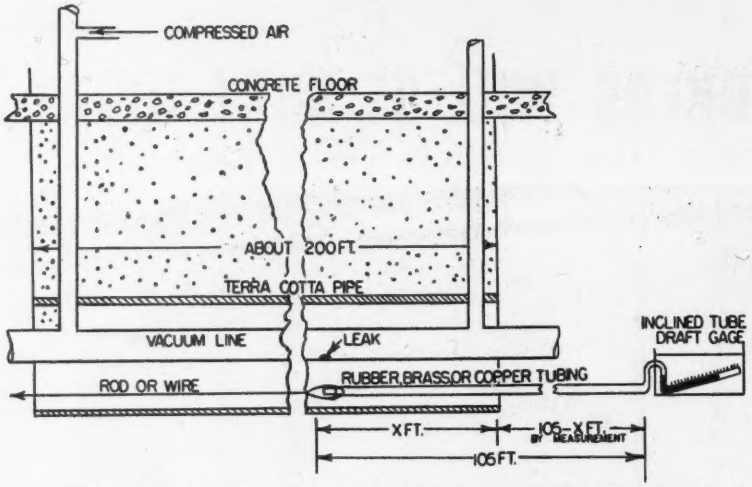
1. *Don't install valves where getting at them means exposure to danger.*
2. *Support lines firmly to prevent loosening at joints.*
3. *Identify valves so they can be quickly operated in emergencies.*
4. *Install relief valves where there is danger of sudden built-up pressures.*
5. *Inspect sprinkler system control valves regularly. Keep them open always.*

The safety hints given here are from "Piping Pointers" Bulletins—a Crane service aiding piping men in hundreds of plants in doing more to help win the war. Giving many "*do's and don'ts*" and "*rights and wrongs*" on keeping pipe lines at peak efficiency—conserving critical metals—and speeding piping jobs, these bulletins, based on Crane's 87-year leadership in flow-control engineering, are especially valuable for training new maintenance men. Copies free on request from your Crane Representative or by writing to: Crane Co., 836 South Michigan Avenue, Chicago, Illinois.



ARMY E NAVY

CRANE VALVES



Mr. Darnell's method of locating leak in underground vacuum line by compressed air and draft gage

Mr. McNally has assumed that the ends of the terra cotta pipe are accessible and can be sealed. Assuming that this is true, instead of sealing the ends I would suggest that a steel rod or wire be pushed through the terra cotta pipe. I would then attach a little over 100 ft. of either brass, copper or rubber tubing to one end to the steel rod or wire, and then slowly draw this tubing through the tile pipe, first from one end and then from the other. Compressed air should be injected into the vacuum line. Wherever there is an air leak, it will be detected by means of an inclined draft gage connected to the outer end of the tubing which is drawn through the tile pipe. Any rise in the level of the draft gage will indicate a leak and the distance from either end of the terra cotta pipe can be measured on the tubing.

Another scheme would be to inject acidified water under pressure into the vacuum line and then cover the steel rod or wire, which is to be drawn through the terra cotta pipe, with some kind of indicator paper, such as litmus paper. Wherever the stream of water, leaking through the vacuum line, strikes the indicator paper, there will be a change in color, and this point can be measured from either end of the terra cotta pipe. However, with the latter method, the operation must be performed quickly before the terra cotta pipe has time to fill with water. It might even be advisable not to inject the water into the vacuum line until the indicator paper has been inserted.

Naperville, Ill. J. R. DARNELL

Answer 199

Should He Raise His Condenser Pressure?

THIS question was asked by E. B. on p. 101 of the November issue. He was operating a 16-t. 2-cylinder ammonia compressor at 140 lb. condenser pressure and 20 lb. suction pressure. Condenser water entered at 45 deg. and left at 80 deg. He used considerable water and he wondered whether he could save water by raising the condenser pressure to 180 psi.

They Eliminated 74 Per Cent of the Water Waste

SHOULD E. B. raise his condenser pressure? POWER PLANT ENGINEERING readers assume that his problem is primarily a question of economy, therefore several factors should be given consideration, such as water vs. electricity, advantage or disadvantage of the final refrigeration result, etc. Nevertheless, I should like to attempt to point out water and current consumption at constant capacity of dry expansion system. The present operation approximately requires 15.5 kw. and 2900 g.p.h. of water, the anticipated operation would require approximately 20.5 kw. and 1500 g.p.h. of water.

E. B. should be in a better position to observe and determine which operation will be most advantageous. Also I should like to add, if the plant is entirely manually operated, installing automatic expansion valve, head pressure controlled water regulator and temperature controlled compressor motor would warrant a better economy. Has volumetric efficiency been considered or partial utilization of the condenser water? On one occasion we eliminated 74 per cent of the water wasted, by supplying the condenser water to our two 3-hp. motor driven dishwashers, revamping some of the equipment and the installation expenses did not exceed $300. The enclosed sketch is self-explanatory and if E. B. would like to have some more information, I shall gladly comply with his request without any obligation.

Schenectady, N. Y. CARL BACHMANN

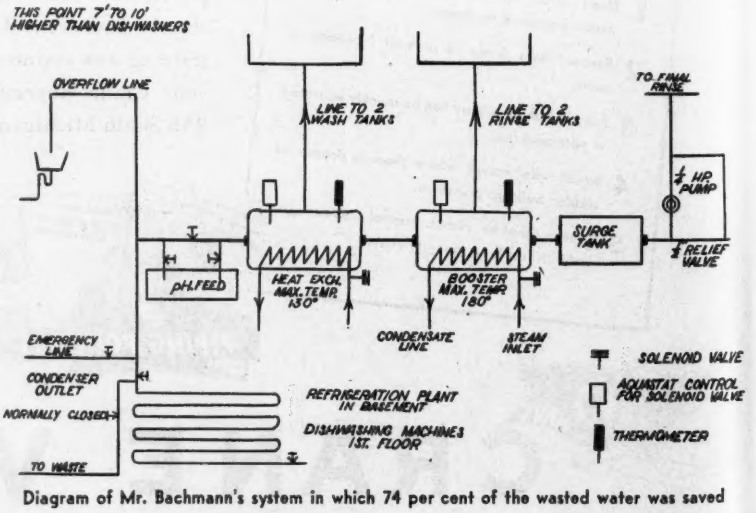


Diagram of Mr. Bachmann's system in which 74 per cent of the wasted water was saved

Answer 204

He Wants Advice on Firing His H.R.T. Boiler

IN THE December issue, Cloyd C. Cahill was in need of advice in properly firing his 72 by 18 h.r.t. boiler. He asked several questions to which Wm. E. Rixman has submitted possible solutions.

Change in Fuel or Using Underfeed Stoker Would Raise Steam Capacity

BEFORE ANSWERING Cloyd C. Cahill, I raise these two questions:

Is efficient use made of the steam generated?

Is there a better grade of fuel at nearly the same price?

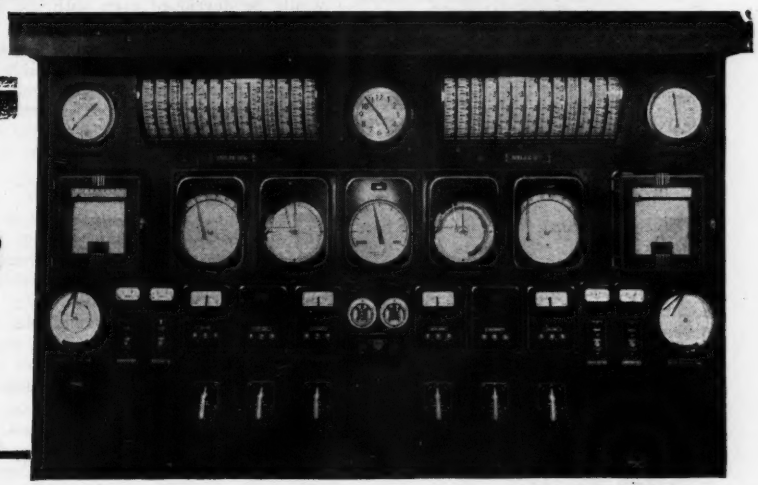
Then—

1. (a) For hand firing, stationary grates, h.r.t. boiler 72 by 18, distance from grates to boiler shell should be at least 36 in.

(b) For underfeed stoker, 42-48 in. This gives suitable heat release rates in the furnace of about 40,000 and 35,000 B.t.u. per cu. ft. per hr., respectively.

2. Bridge wall to be within 14-18 in. of shell, depending on firing method.

3. Boiler capable of 4500 lb. steam per hr. So a 6 by 4 or 6 by 5 ft. grate should satisfy a minimum of alterations.



A REAL *CONTROL CENTER* FOR YOUR POWER PLANT

ALWAYS on the alert to detect signs of combustion trouble and quick to correct it Hays Automatic Combustion Control stands guard over your power plant . . . a real CONTROL CENTER.

It performs *automatically* what a crew of operators would do manually to maintain an even steam pressure under fluctuating demand.

It never gets air-raid jitters, never minds long hours, never gets tired, nor forgets. It's on the job 24 hours a day, seven days a week.

It relieves man power and stretches steam capacity by keeping air and fuel rates in accurately measured proportion to each other and in direct relation to the plant load.

It permits operation of your boilers closer to their maximum capacity with a greater degree of safety and economy than possible under manual operation. It stretches steam capacity.

Hays Centralized Automatic Combustion Control is a real CONTROL CENTER for your power plant—vital to all-out war production. Send for latest literature . . . it may be helpful.

THE MODERN SYSTEM *It's Electrical*

HAYS *Automatic* **COMBUSTION CONTROL**

THE HAYS CORPORATION • MICHIGAN CITY, IND.

4. Hand firing straight furnace should increase steaming capacity over old coking method, which is notably slow. However, I believe a free burning fuel would help this steaming problem, if we could minimize the smoke nuisance.

A small underfeed stoker would practically double the present steaming, use cheaper fuels efficiently, and could be installed with a minimum of furnace change. Spreader type stoker would be effective also, burning all coals easily.

The next problem here would be the safety valve capacity.

Cincinnati, Ohio — WM. E. RIXMAN

Answer 211

High Speed Conveyor Operation

IN THE JANUARY, 1943 issue, Robert Baker asked what might have been the cause of the overspeeding of a rewound, 17-hp., 970 r.p.m. shunt-wound d.c. motor driving a coal conveyor. When it was reinstalled and first operated, it whined like a shell coming down and ran so fast the conveyor buckets were just a blur. They stopped it in time, then the electrican changed some connections, tried again — and it ran backwards! On the third trial he got it running right. Baker wanted to know what happened and why.

Several explanations of this have been offered. R. E. F. leads off with what seems to us a very good explanation. Dean Pettit's and Sam Williams' comments are based on an idea slightly different from R. E. F.'s as you will see, while Carl Bachmann's comment is along the same line as R. E. F.'s but in passing touches on the idea Pettit brought up. So, after you have read all four of them, you should really know something about shunt-wound motors.

The Small Amount of Series Winding May Explain It

THIS IS in reply to the question about the excessive speed of a shunt motor driving a bucket conveyor.

Theoretically a shunt motor has only a shunt winding, but actually it very often has a small percentage of series winding. The reason for this is that a pure shunt wound motor may increase in speed as the load comes on, because the armature current "kills" some of the shunt field flux. To overcome this tendency, a very few series turns are added to the field poles in such a manner that they will add to the shunt field flux and hold the speed down as the load builds up.

What may have happened to cause excessive speed was that this series field was reversed, so that, instead of correcting the "armature reaction," it made it worse and doubled the tendency of the motor to over-speed instead of cancelling it. On the other hand, the shunt winding may have been disconnected altogether and the motor was started with only a very light series field. This would cause even greater speed, assuming that the field was heavy enough to give the motor enough torque to start. When the motor was started the second time, the fields were evidently correctly connected except that the shunt field was reversed which would cause the motor to reverse its rotation.

Between the second and third starts the electrician evidently reversed the shunt field, which would reverse the direction of rotation, and also took care to see that the series winding was correctly connected.

New York. — R. E. F.

Did Shunt Field Winding Get Current at First?

THE REASON the d. c. conveyor motor ran so fast was due to some error in connecting the shunt field winding. It was connected so that it did not receive any current, therefore the field pole magnetic flux was practically nil. This error could occur either at the starting box or at the motor connections.

With a shunt motor lightly loaded, as happened in this case with the conveyor empty, appreciable starting torque would be developed even with the field circuit dead, due to the reaction of the magnetic field of the armature against the iron in the field poles. Possibly the job was overmotored, which would aid the phenomenon. The case is similar to the overspeeding of a series-wound motor, as explained in almost all texts dealing with d.c. motors.

Assuming other conditions unchanged, the speed of the motor would be governed by the counter-voltage produced in the armature as it rotates in the field flux. This counter-voltage opposes and is always less than line voltage. Under normal conditions, the difference between these two voltages is small, permitting only sufficient current to flow to rotate the armature at the proper speed for the load on the motor. With the field circuit dead, the situation is changed. The counter-voltage sinks to a very low value, causing the armature to draw a heavy line current. Since for a given field strength, the only way voltage can be changed is to increase the rate at which the armature windings pass through the field flux, the armature attempts to do just that by increasing its speed. In fact, the speed necessary for sufficient counter-voltage to bring the armature current down to proper value is in some cases so great as to cause destruction of the armature by centrifugal force. Evidently the conveyor was sufficient load to prevent this.

If the conveyor had been loaded the motor probably could not have developed enough torque to roll over, and if left connected too long would blow the line fuses or perhaps burn out some of the resistance units in the starter. The latter condition sometimes happens where the motor is overloaded, or has a defective bearing, or the driven equipment is "stuck," and an attempt is made to start it by inexperienced help. On most d.c. starters this would "kill" the shunt field, because its current has to travel back through these resistances when the motor is in operation.

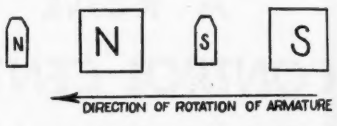
When the conveyor ran backward, the field poles were of the wrong polarity in relation to the magnetic field of the armature, to produce correct rotation. The electrician made the motor rotate in the right direction merely by interchanging either the shunt field leads or the armature leads.

Shunt and series wound motors are not the only star performers in overspeeding acts. The compound-wound machine can do just as well. Belt-driven, compound-wound, d.c. generators operating in parallel, if one of them has a belt kick off, have been known to give thrilling experiences. If conditions are favorable, the series field can overcome the shunt field causing the generator that has lost the belt to motorize and overspeed.

Ellicottville, N. Y. — DEAN B. PETTIT

Carl Also Suspects Series Winding, Says Look for Interpoles

FIRST I should like to suggest that he recheck the motor physically and not the name plate only. In my past experience, I have observed many d.c. motors marked shunt-wound, although proved to be compound-wound. Nevertheless, we assume that this motor is shunt wound, but surely it must be equipped with commutating or interpoles in order to demonstrate such a show—which by the way could have caused another rewind job.



Bachmann's diagram showing the interpole arrangement

Since he is primarily interested in knowing what made the motor race, I shall try to explain it, short and sweet. The electrician connected the motor first without the shunt winding, operating the motor like a series motor, which caused this racing. Recapitulating Mr. Baker's hair-raising experience with the electrician's hit or miss connections of the motor, I am still in doubt that it is YET properly connected, although it appears to be running all right.

I should like to suggest to check the main poles and interpoles, which are small poles placed between the main poles and connected in series with the armature circuit. Follow the direction of rotation; after the (S) main pole a (s) interpole should follow, etc. This is different from generators.

Schenectady, N. Y. — CARL BACHMANN

Sam Also Says No Field Current

THE FACT that the electrician's second attempt at wiring resulted in a reversal of the motor, operating at rated speed, would indicate that on the first trial the motor was running on residual field magnetism only. Of course, the greatly weakened field would allow the tremendous increase in speed. On the third trial, the electrician evidently got the shunt field connected correctly. It was fortunate that a heavy permanent load was connected to the motor, otherwise there would have been many small pieces of copper armature wire to clean up.

Wingdale, N. Y. — SAM WILLIAMS

DID YOU EVER SEE 5 BOILERS EXPLODE?

Neither had we as we stood out of breath on the nearby hill, knowing that we had done everything possible to stop the fire. The frame structure that housed our five boilers was a mass of flames—there was only one thing left to do and that was 'scram.' We made the hill and we waited—there was one satisfaction to the boss—the boilers were insured. Still we waited and watched the flames play up and down the boiler stack. Out of the stack, as we could see through the flames, the smoke curled from the working boilers just as if nothing unusual were happening. Then all of a sudden there stood the five boilers—the frame exterior had crumpled to the ground—still the chimney smoked and we waited and waited."

This happened a good many years ago. The facts are in the insurance inspector's report. He credited the COPES Feed Water Regulators with saving these boilers. They continued to operate through smoke and fire after the crew had fled—they kept the water level safely above the tubes.

Dramatic, you say? We say this kind of protection is everyday performance for COPES on more than 65,000 boilers.

These are the facts given to our service man and to the insurance inspector.

You will want to know more about the regulators that protect over 65,000 boilers. Write for general catalog.

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432 Grove Drive, Erie, Pennsylvania
FEED WATER REGULATORS • PUMP GOVERNORS • DIFFERENTIAL VALVES
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★ GET CLOSER LEVEL CONTROL WITH THE COPES FLOW-MATIC ★ REGULATOR

FEEDS BOILER ACCORDING TO STEAM FLOW-AUTOMATICALLY

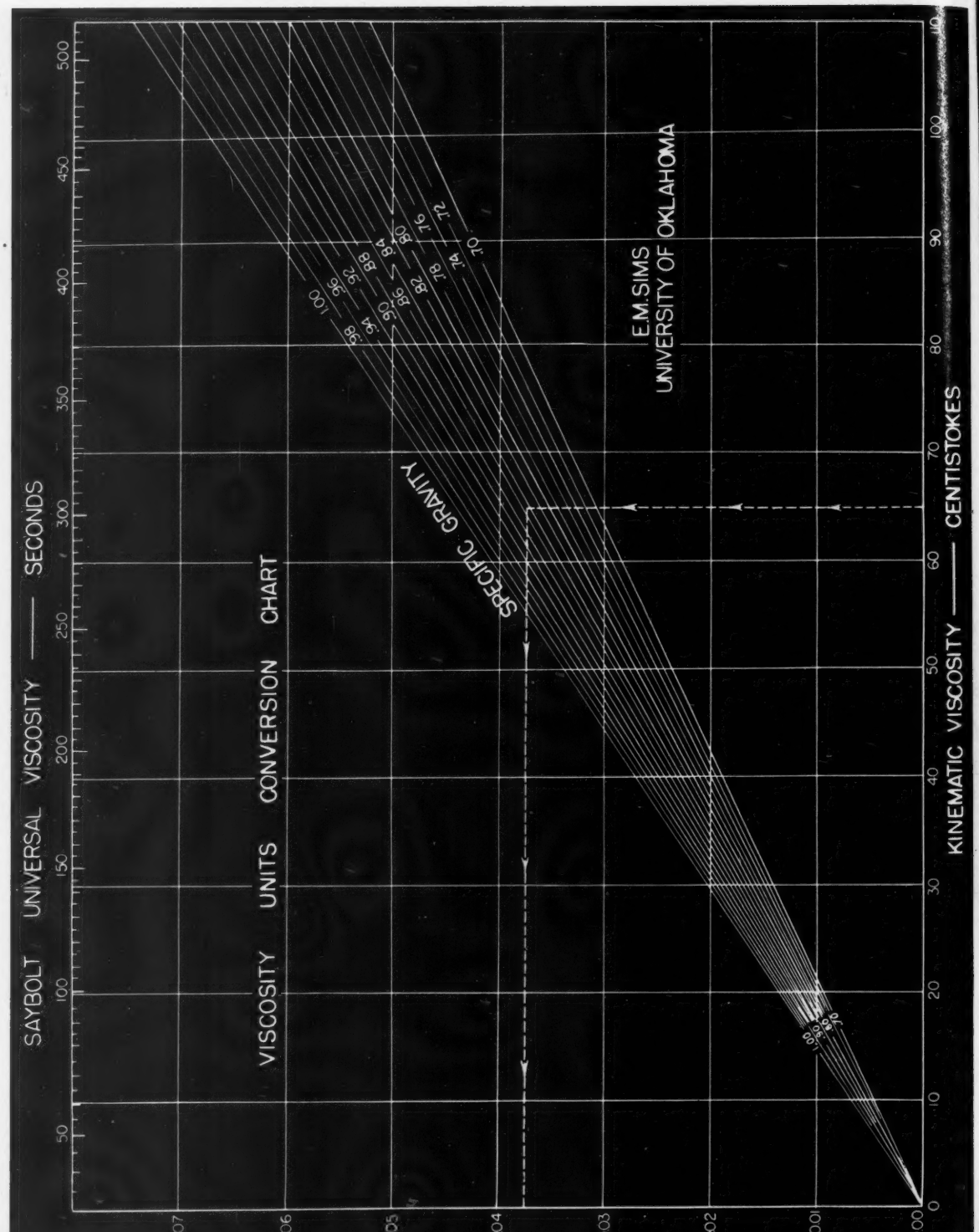
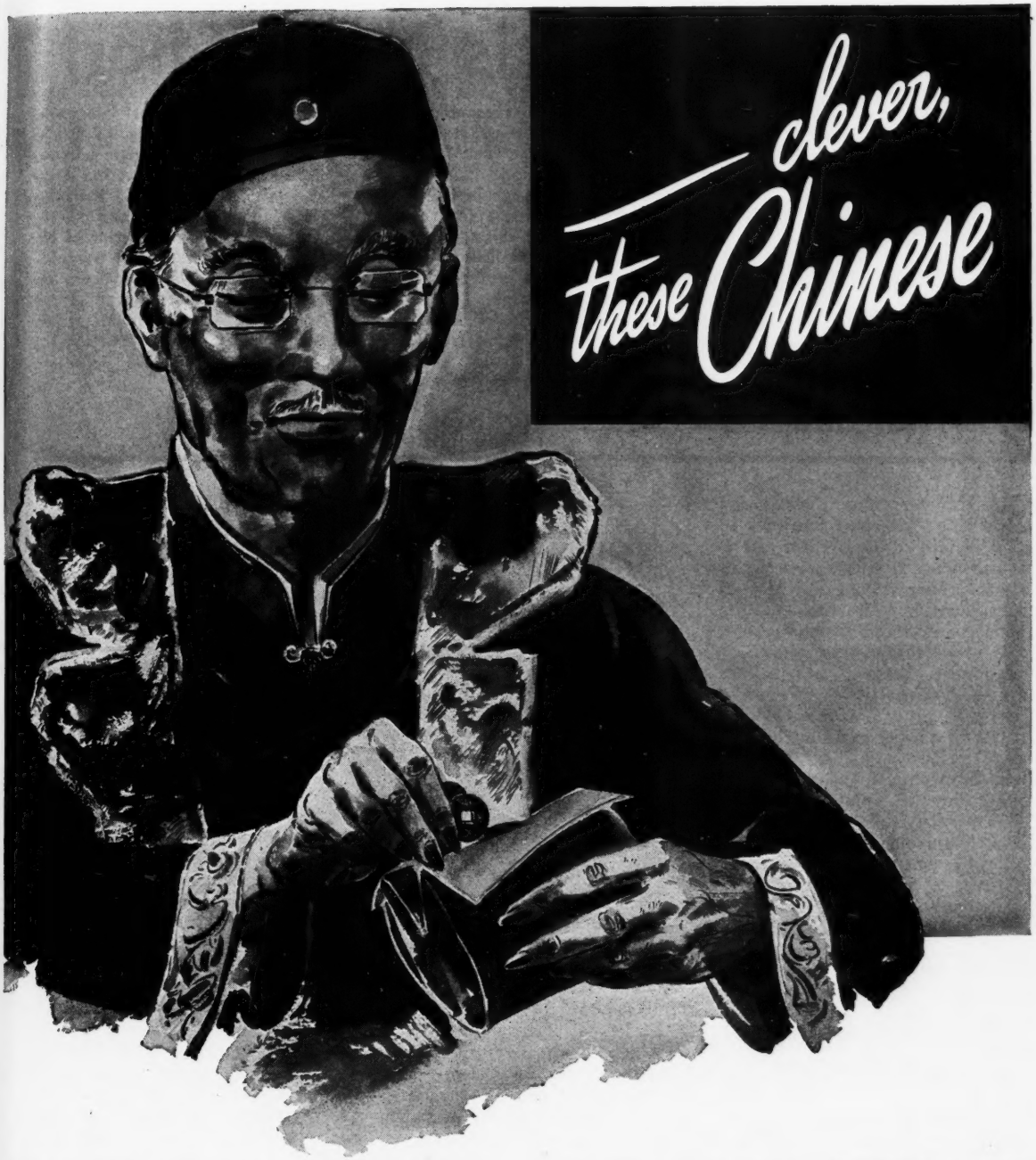

SAYBOLT UNIVERSAL VISCOSITY —— SECONDS
VISCOSITY UNITS CONVERSION CHART
SPECIFIC GRAVITY
E.M.SIMS
UNIVERSITY OF OKLAHOMA
KINEMATIC VISCOSITY —— CENTISTOKES
ABSOLUTE VISCOSITY — LB (MASS) PER SEC FT UNITS

Chart for Determining the Absolute Viscosity of Oils.

This chart provides a means for determining the absolute viscosity of oils in English engineering units from physical test data obtained by the use of either the Saybolt Universal, Suspended-Level or Modified Ostwald viscosimeter. It may also be used to convert viscosities expressed in centistokes to the equivalent viscosity expressed in Saybolt Seconds or vice versa where a high degree of accuracy is not required.



The age-old Chinese custom of paying the physician to *keep well* reflects the wisdom of this ancient race. Prevention is far better than cure.

And likewise, in industry, boilers that are protected from breakdown by intelligent and continuous feedwater conditioning will continue to operate at maximum steam output with a minimum of time out for overhaul

W. H. & L. D. Betz is an organization of engineers and chemists, trained and skilled in the science of boiler feedwater conditioning for the prevention of scale, corrosion, carryover and embrittlement. Our service is complete for all industries, with prescribed treatment specifically recommended for individual requirements.

We have laboratories and engineers located throughout the United States and Canada.

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CHEMICAL ENGINEERS AND CONSULT

Where a Short Is Not a Short*

In February, 1940, we presented a short article entitled, Electrical Energy in Balance. This article, as we indicated at the time, was a rather unusual article dealing with a somewhat unorthodox method of transmitting electrical energy. Strangely enough, despite its fundamental interest the article attracted little attention because we received little comment on it. Still believing that the ideas developed by the author of that article have merit, we present here, another article by the same author dealing with a further development of his ideas on electrical transmission. He calls it another stage of parallel transmission. In this system, a total short circuit or a direct ground has practically no effect upon the operation of the system. The principle involved is unique but very simple and where reliability is of prime importance, it seems circuits of this type should have commercial value. We will welcome discussion of this subject

By John K. Masten, "Hobbyist"

SIMPLY to transmit electricity through balanced branches so it be certain of arrival for use is not sufficient. It must also be available at proper voltage and in sufficient quantity. The final circuits described in the February, 1940, issue provided for the opening of a grounded branch but did not furnish compensation for increased line losses.

Let us progress a step beyond that previously outlined and examine the simple single-phase alternating current circuit comprising two separate transformers to feed parallel branches of transmission and two others to reunite the branches, letting the arrows define momentary direction of flow.

In order to forestall possible thoughts of burnt out transformers consider first as an example of their characteristics, each primary

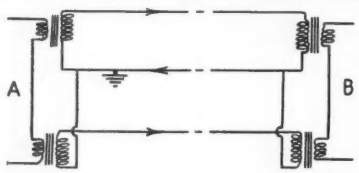


Fig. 1. This circuit possesses voltage compensating tendencies with one transmission branch grounded. Transmission branch potentials tip in see-saw like relation while the source and destination potentials remain reasonably constant

at source (A) (Fig. 1) as being constructed to operate at 200 v. but in the circuit shown the application of 200 v. to the series arrangement operates the source primaries at about half this value so that the shorting of either raises the other to the 200-v. maximum, with a corresponding increase in the secondary voltage. Careful study of the entire circuit will show that with load at (B), such a short does not with properly designed transformers cause a radical increase in current flow anywhere in this system.

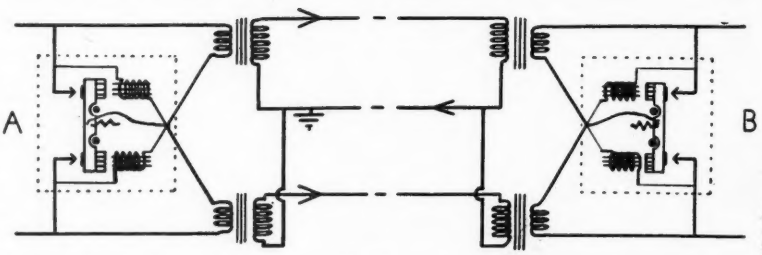


Fig. 2. Showing the addition of potential difference relays to insure positive operation of the system even on partial short circuit

For the purpose of analysis only, assume: first, that "total shorts" are possible, and second, that a totally shorted transformer secondary also produces in effect a totally shorted primary.

Under such an assumption a short circuit in the upper transmission line would completely short out the upper half of the entire circuit. The burden of transmission would be relayed to the lower half of the circuit. Voltage compensation would occur and, providing transformer characteristics were properly manipulated by design, the voltage at (B) would remain unchanged.

The occurrence of a direct short of a transmission line to ground would not more than momentarily increase the flow energy through this path. Instead, the natural path toward greatest energy consumption would become the unshorted of the two lines and this would be the desired course.

We have here what at first glance might appear a paradox—a direct short circuit in which no energy would be consumed as waste beyond that of a momentary discharge.

A partial short, however, would both consume and waste energy

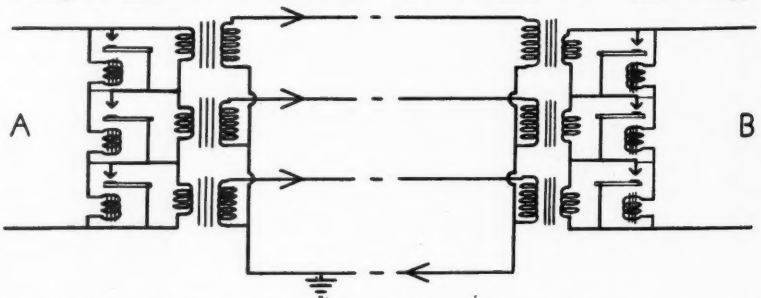


Fig. 3. A three-branch circuit in which the potential difference relay has an armature with three "fingers" one of which closes the faulty circuit

*All rights reserved by the author.

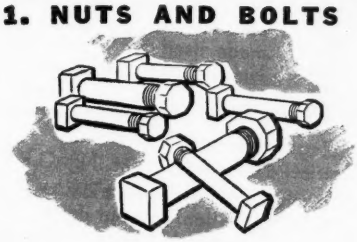
Welding piping with Tube-Turn fittings conserves 4 vital materials . . . checks war-time pipe failures, stops leaks!

NO. 4 OF A SERIES

HOW TUBE-TURN WELDING FITTINGS BENEFIT WAR INDUSTRY

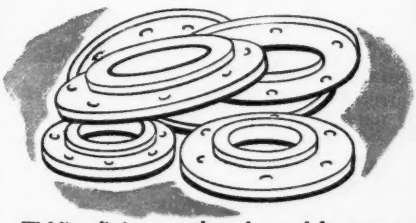
The FIRST WELDING FITTINGS 1st AND STILL THE BEST

1. NUTS AND BOLTS



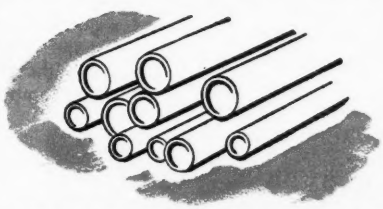
Joints welded with Tube-Turn fittings require no nuts or bolts. Maintenance time and trouble spent in tightening bolts is eliminated.

2. FLANGES



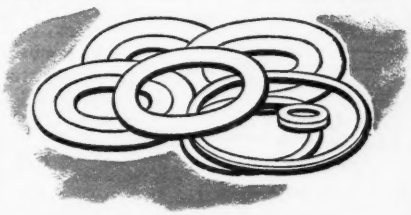
Welding fittings supplant the need for many of the flanged joints necessary in screwed piping—save both weight and critical metal.

3. PIPE REPLACEMENT



When welding fittings are used, you never have to replace any pipe because of worn threads or damage due to replacing flanged fittings.

4. GASKET MATERIAL



Fewer flanged joints mean fewer gaskets to replace. No materials or time wasted when connections are welded with Tube-Turn fittings.

When you multiply these savings over an entire piping system, the amount of critical materials conserved is tremendous. Tube-Turn welding fittings aid the war effort in *other* ways, too—less danger of plant shut-downs due to piping failures; maintenance is virtually eliminated; less installation time is needed because alignment is easier, only simple butt welds are required, and complete sections may be pre-assembled then welded into position. For *stronger, lighter, permanently leakproof* piping systems—weld with Tube-Turn fittings!

TUBE-TURNS (INC.) LOUISVILLE, KY. *Branch offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Tulsa, Houston, Los Angeles. *Distributors in principal cities.*

TUBE-TURN

TRADE MARK

Welding Fittings and Flanges

although voltage compensation would still occur. An analogy may be drawn between this and the action of a mechanical differential unit wherein one side of the differential will consume mechanical energy if retarded yet will not do so if locked stationary.

Shorts having appreciable resistance, therefore, are not as desirable with this arrangement as total shorts having practically no resistance. As shown below, however, arrangements using auxiliary devices can be used to overcome the limitations imposed by resistance.

(By converting this system to a 3-wire system with grounded neutral a voltage compensating system is again provided; however, unlike the circuit shown, potential would exist between the two outside wires.)

Auxiliary Devices

The addition of auxiliary units as shown in the arrangement in Figs. 2 and 3 supplements the circuit action by directly shorting the circuit side in trouble. The armatures normally balanced by spring and magnetic influence will close a partially shorted circuit, for any

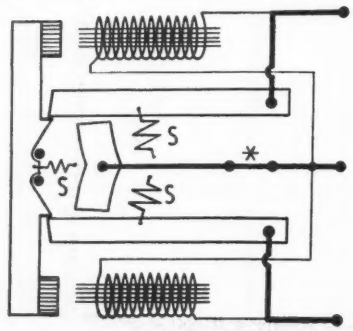
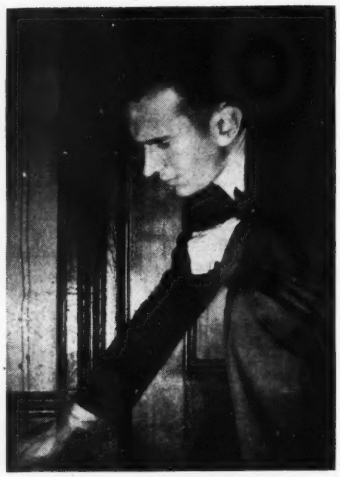


Fig. 4. Showing a method for stabilizing the armature by means of spring operated latches and switches to carry heavy loads

drain upon a branch reduces the attraction upon that side of the armature.

Increase of the number of branches, employing one armature with a separate finger for each branch, benefits the action, and lessens the problem of transformer construction to provide efficient operation at either of two voltages; however, high transformer efficiency during single branch operation is not a necessary prerequisite to effective results as this emergency operation is not meant for permanency.

(*Continued on page* 136)



IT WILL be noted that Mr. Masten calls himself a "Hobbyist." This appelation is of his own choosing. Whatever he may call himself, however, the fact remains that he is a keen student of electricity and electrical phenomena and if he were less modest he might call himself a research scientist or something else equally fancy. In response to a request for something about his "background," Mr. Masten writes as follows: "I wish I had more to offer you in the way of education and experience . . . Perhaps the best I can offer is an impelling inherited urge to experiment which made itself felt in wordless thought long before school days. Early wireless and radio temporarily satisfied this urge and a 2-yr. course in electricity gave me a basic understanding of things electrical.

"As a clerical man in the Electric Power Department, N.Y.C.R.R., Grand Central Terminal I made out so much better than electrical men that I remained, but due to youth and seniority regulations lost out during the depression and eventually landed in the Station Master's Office. Tricks of circumstance never made it possible for me to start in the electrical field and obtain security equal to that as a clerk . . . So here I am a hobbyist with as queer an accumulation of unorthodox mathematical and electrical knowledge as you would care to see, and with little notion of what to do with it. Being neither a mathematician nor a mechanical engineer, traditional thought seldom presents a great barrier to intuitive thought as it might with others more formally trained. I have delved into subjects which required "unlearning" (which is different than forgetting and more difficult than learning) but being possessed of a peculiar type of ignorance, at such times I do not have to unlearn nearly so much as might the advanced student—not that I do not envy him . . . Numerous trivial things have been discovered, a good proportion of which must have been known, but not all . . . Suppose you became interested and curious as to the structure of π and in employing simple arithmetic discovered indirectly that you could express the year 1943 in parallel numbers and counterparts like this:

$$\frac{1943.0000\text{——}}{1.0000\text{——}} \text{ or like this } \frac{002.060445\text{——}}{.001\,060445\text{——}}$$

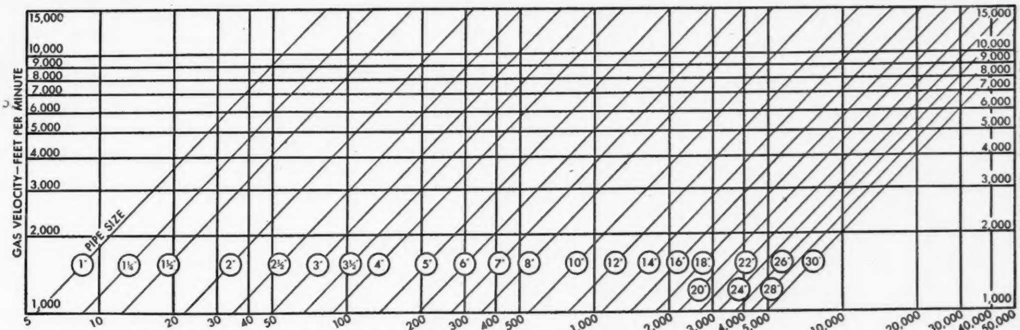
The next fellow may say "so what" or at best display a passing interest. In either event he will take it for granted. But where a person discovers it (and should it prove to be rediscovery, no matter) he is amazed at himself. He is blessed with the fruits of labor and looks to see what else there be, whether anyone cares or not. Hobbies are like that; you keep right on building with never an end in sight . . . The hobbyist dares to try simple approaches to the accepted impossible, knowing full well that all sorts of ingenious complex approaches have failed, and frequently attains a measure of success if not what he sought. A 6-yr.-old child could easily be taught to count and calculate in a foreign numeral system having one less figure, as though the symbol 9 had never been invented. An adult, however, with his deeply imbedded lifetime knowledge cannot be expected to throw off these shackles without a struggle . . .

"Since my electrical experiments were conducted in a 2 by 4 home laboratory under difficult conditions and with not very presentable apparatus, I have no good photographs to offer you. To my knowledge, these circuits are not in commercial use though they could well be. If not, it seems they ought to be. When an inspiration strikes, it is not good to know how others approached the problem, assuming they did, until you first find out what creative thinking brings forth; then is the time to compare notes."

In presenting these passages from one of Mr. Masten's interesting letters to the editor, we feel that they will add to the reader's interest in his article. As he points out, the circuits he describes may be in commercial use and if they aren't it does not matter; his approach to the problem is still interesting.

GESS—ORIGINATORS OF SNUBBING PRINCIPLE FOR QUIETING DIESEL EXHAUSTS—BURGESS—ORIGI

BURGESS SNUBBER BULLETIN on Diesel Exhaust Noise Control



Each slanting line represents the pipe diameter indicated in the circle.

Velocity Ranges—2 cycle

Crank Case Scavenged	to 3000 FPM
Low Speed Positive Scavenged	4000-7000 FPM
Medium Speed Positive Scavenged	6000-8000 FPM
Medium High Speed Positive Scavenged	7000-9000 FPM
High Speed Positive Scavenged	8000-10,000 FPM

Velocity Ranges—4 cycle

Low Speed	4000-7000 FPM
Medium Speed	6000-8000 FPM
Medium High Speed	7000-9000 FPM
High Speed	8000-10,000 FPM

NEW GAS FLOW CHART SIMPLIFIES CHOICE OF EXHAUST PIPE SIZE

Engine operators and designers frequently have occasion to specify or select engine exhaust pipe sizes. This has always been a complicated job because no simple way of relating pipe size to gas flow had been devised. It was necessary to figure each exhaust pipe individually from a standard formula for gas volume.

After going through a great many tedious calculations to determine proper pipe sizes, Burgess engineers worked out the simple chart shown above which makes the selection of pipe size a matter of seconds. The user simply takes the gas velocity in feet per minute and the gas flow in cubic feet per minute, picks out the point which graphically represents these two values, and the proper pipe size is shown automatically.

This chart is based on the common hydraulic formula $Q = A \times v$. For a round pipe this becomes $Q = \frac{\pi D^2}{4} \times v$, and D can then be found when Q and v are known. Plotting the value of D produces the chart shown above. It may be used to find round pipe sizes for exhaust gas and intake air or for blower air flow.

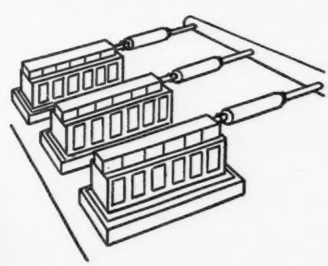
Copies of this chart, in a form convenient for use, will be supplied to interested persons upon request.

★ ★ ★

HELPFUL HINTS

Using Snubbers with an Exhaust Header

While it is often convenient to attach several exhausts to a header, this should not be done unless the exhausts have been quieted first. It can be done successfully when each engine is individually equipped with a Snubber, because the gases then flow smoothly into the header. Oscillation and vibration are eliminated by the Snubber.



One large Snubber should not be used on the header to quiet all engine exhausts because (1) if one or more engines are shut down, the Snubber will not be the proper size for the remainder, and (2) oscillation of gases out of one exhaust pipe into another takes place unless the gases pass through Snubbers before reaching the header. This would result in noise and vibration, and might lower engine efficiency.

An exhaust system with Snubbers like those shown above should operate satisfactorily.

★ ★ ★

Minnkota, N. D., Cooperative

This new power plant, located in North Dakota, is one of the most attractive of its kind ever built. Financed by REA, it will service thousands of farms lying in the area around it, less than one per cent of which had previously been supplied with electricity. Seven distribution cooperative stations receive power from this plant at high voltage, distributing it to customers at standard voltage.

The floor area of the main building is planned to accommodate six 1000 hp Cooper-Bessemer engines, but at present only three are installed. The other three are on order and will be put in place after the war, or earlier if this power source should be needed in furthering the war effort.

Each engine exhaust is equipped with a special 12" combination Snubber and waste heat boiler that eliminates exhaust noise and provides steam. The three units are expected to deliver adequate heat even in severest weather.

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GESS—ORIGINATORS OF SNUBBING PRINCIPLE FOR QUIETING DIESEL EXHAUSTS—BURGESS—ORIGI
COMPLETE SATISFACTION IN EXHAUST AND INTAKE QUIETING—SPECIFY BURGESS SNUBBERS—FOR CO

OFF THE RECORD

Accurate records, the tell-tales of good or bad plant operation, are always of importance to the chief and operating engineers, but during times of war, when conservation of fuel and materials is the patriotic duty of everyone, the subject of records takes on new importance. This discussion of power plant records covers chiefly the small plants where factory-trained instrument men and graduate chemists are not full time employes of the plant

By LeRoy E. Varner, Chief Engineer, The Penn Mutual Life Insurance Co.

A FEW YEARS ago, I visited a plant to check the claims made by an oil burner concern which had converted the boilers from coal to oil firing. I found the over-all efficiency of the plant very good. As a matter of fact, according to the records, their boiler efficiency was 102 per cent. What was the trouble? Instruments recording accurately—no one interpreting the records. The chief was too busy in the plant, and the plant engineers couldn't, or if they could, just hadn't gotten around to it. I am sure that this is not your case, —or is it?

Actual Value of Plant Records

The reason that indicating and recording instruments are installed, is to make it possible to economically control day to day plant operation. Since the instruments are merely tools through which this is accomplished, the records are of little value unless checked and interpreted daily.

I well remember the expression on the face of the chief engineer of a plant in New York State, where I spent a week at the request of the directors of the company, checking the plant's operation, when I told him I was not interested in his records of the past year. What his plant was doing the day I arrived, according to my own findings, told the story, and it wasn't necessary to look at the records. The important thing was what improvements could be made in his day to day use of the records to improve plant operation.

Here at Penn Mutual, our operating engineers record all instrument readings on a boiler room log sheet, and this, together with the instrument charts, is delivered to the chief engineer's office every morning. The first job in this office is to check the records daily, calculating boiler efficiency, per cent ratings, etc., for the previous day, and transfer the figures to a monthly record sheet (Fig. 1).

The records are transferred daily to a monthly record sheet by hand in ink by the chief engineer simply because by so doing, the check is positive, and one is able to spot trouble quickly if the results are written down under comparable figures daily.

From the monthly record sheets, the figures are totalled or averaged, and placed on 5 in. by 8 in. cards for permanent record (Fig. 2). The daily log sheets, charts, and monthly record sheets, are usually kept for 3 yr., but have seldom been referred to. It might be interesting to note that 7-yr. permanent records can be kept on the cards shown.

Are Your Recording Instruments Accurate?

Too frequently, I have found that engineers have been satisfied with the readings taken from recording instruments over a long period of time without having checked the instruments. This is true especially where the results of the readings appear to be good.

I recall some time ago, an incident which happened in a hotel property in Philadelphia, where the building management decided to pay a bonus to the firemen for maintaining a high rate of CO_2. The records showed that shortly after the bonus became effective, the CO_2 readings increased considerably and remained there for some time. An instrument man found, at some later date, that the instruments had been mechanically adjusted upwards.

Instrument records are of little or no value unless the instruments are checked regularly by a competent person. Inaccurately recording instruments today are the equivalent of a 'fifth column' operating in your plant.

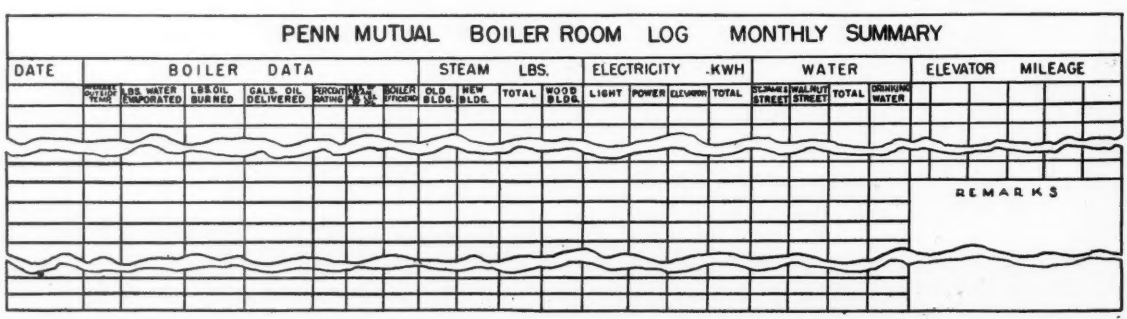


Fig. 1. Monthly summary sheet from which costs of plant services are calculated

facts

concerning replacement parts for

DE LA VERGNE DIESEL ENGINES

America's war production has created unprecedented demands for De La Vergne diesel engines. Our shops are working 24 hours a day, producing De La Vergne diesels to aid our armed forces to bring Victory at the earliest possible moment. Naturally, new diesel engines must come first. But in spite of this, we are doing everything in our power to produce replacement parts despite the difficulty in securing critical and other materials.

You can aid the war effort, yourself, other owners and us here at Baldwin by ordering only those replacement parts you need to keep your De La Vergne in operation. We will do our best to get you what you need, as quickly as we are permitted to make and ship parts.

Your cooperation and patience will be sincerely appreciated, by us, our many customers and those units of the armed forces which are using De La Vergne to speed Victory. Baldwin De La Vergne Sales Corp., a subsidiary of The Baldwin Locomotive Works, Philadelphia, Pa.

BALDWIN

De La Vergne

SALES CORP.

SUBSIDIARY OF THE BALDWIN LOCOMOTIVE WORKS • PHILADELPHIA

We have followed a practice for some time, of dividing and subdividing our operation and maintenance cost accounts. The accounts are set up as follows:

1. Salaries and Wages
2. Printing and Paper Supplies
3. Telephone
4. Elevator Service
5. Philadelphia Electric Bills
6. Fuel Oil
7. Coal
8. Laundry—Outside
9. Furniture and Fixtures
10. Water
11. Lamps
12. Electrical Supplies
13. Boiler Room Supplies
14. Plumbing Supplies
15. Carpenter's Supplies
16. Painting Supplies
17. Pneumatic Tube Supplies
18. Heating and Ventilating
19. Air Conditioning
20. Porters' Supplies
21. Wash Room Supplies
22. Miscellaneous

When materials are ordered, the person writing the order codes the requisition according to the above listing. When the bills are received by the Purchasing Department, the bill and requisition are matched and the code number placed on the bill before it is sent to the Auditing Department. In the Auditing Department, the bill is audited in the account number marked on the bill.

In this way it is possible for us to obtain each month in the Cost Accounting Department, the exact amount spent for maintenance supplies in each and every department as well as the cost of operation. When a bill is received for which an order has not been placed, such as a water bill, or an electric bill, the Purchasing Department simply codes the bill according to the above listing before it is passed on to the Auditing Department.

Maintenance Job Records and Job Cards

Our maintenance jobs are called in to the chief engineer's office usually by department heads. The person receiving the call records the job and the time it was received on a maintenance job sheet. The job in turn is called in to the shops, and when the work is completed, the shop mechanic reports back to the office giving the time the job was completed. In this way, it is possible for us to keep a record of not only the number of maintenance calls, but also the approximate time taken to complete them.

Many companies, I understand, are using the job card system of checking maintenance employes' work. As a matter of fact, this system was used here until a few years ago. By job card, I mean a card which is filled out at the end of the day by a maintenance or other employe, stating that for the first 2 hr. this morning he repaired a fixture light in Mr. X's office; for the next 3 hr., he repaired a motor in Mr. Y's department; for the next hour, he took a snooze (meaning he spent it in the shop), etc.

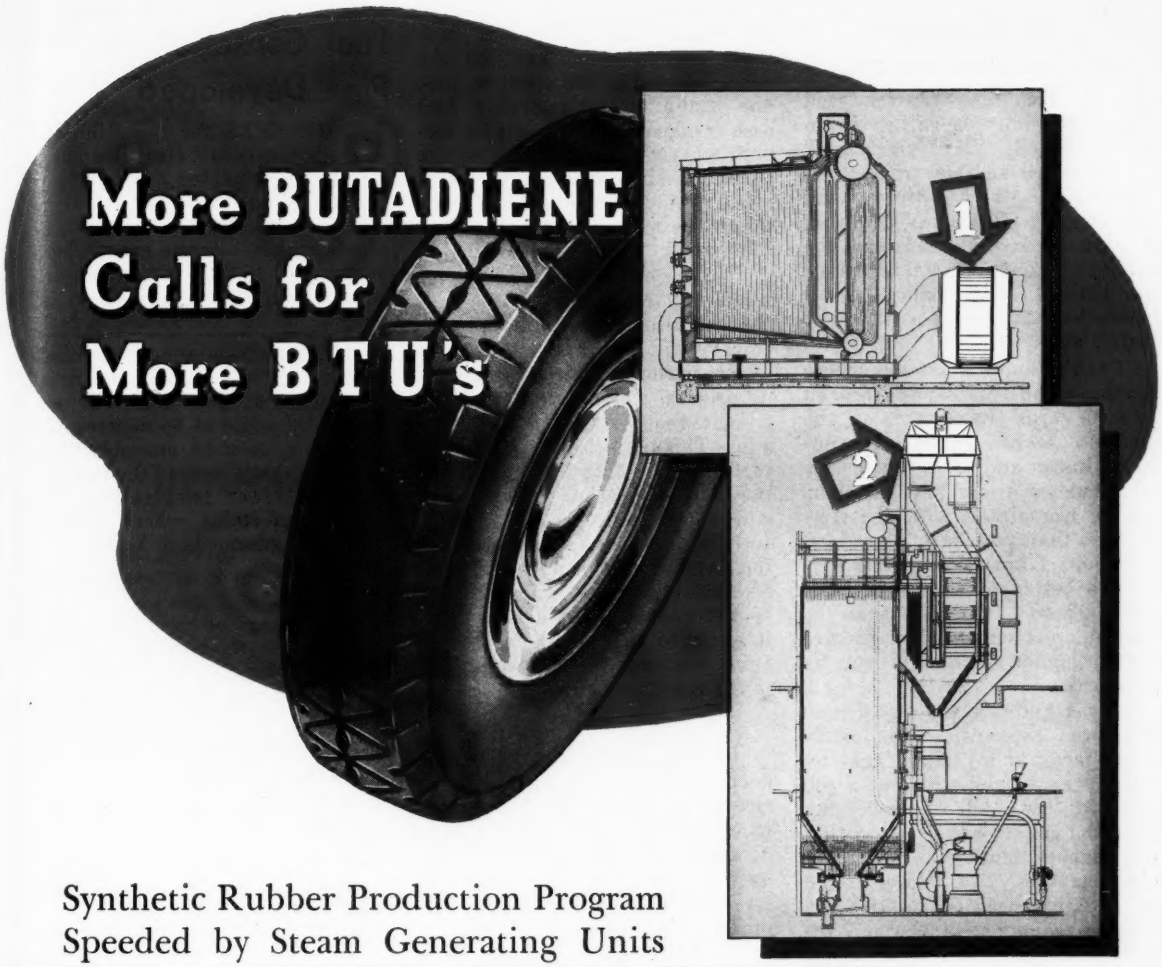
I have found such records, after a number of years, to be worth little more than the cost of the few tons of paper they have been written on. When I was a maintenance man, I had the task of filling out one of these cards each day. The difficulty with my cards was that they very seldom told the truth, for it was very difficult for me to remember whether I worked on this job three-quarters of an hour, or that job for 2 hr., etc., and I, like everybody else, never spent too much time in the shop—according to my job card. And then, of course, there were times when I, like everybody else, didn't get around to filling out Monday's job card until Wednesday, and then what I did on Monday was just a good guess.

I recently met a man who pointed with quite some pride to such a system of keeping maintenance employes' records, and

DRINKING WATER— CUBIC FEET
WATER TOTAL— CUBIC FEET
WATER-WALNUT ST.- CUBIC FEET
WATER-ST JAMES ST.— CUBIC FEET
PHILADELPHIA ELECTRIC BILLS
ELECTRICITY KW.H. TOTALS
ELECTRICITY KW.H. (ELEVATOR)
ELECTRICITY KW.H.(POWER)
ELECTRICITY KW.H. (LIGHT)
STEAM LBS. TOTAL
STEAM LBS. WOOD BUILDING
STEAM LBS. OLD BUILDING
STEAM LBS. NEW BUILDING
BOILER EFFICIENCY (PERCENT)
LBS. OF STEAM PER.POUND OF FUEL
BOILER RATING (PERCENT)
WATER EVAPORATED (LBS.)
FUEL BILL
FUEL GAL. AND LBS. DELIVERERED
COAL (LBS)
FUEL GAL. AND LBS. AS FIRED
DEGREE DAYS
AVERAGE OUTSIDE TEMPERATURE

MONTH	1940	1941	1942	1943	1944	1945	1946
JANUARY		31.8	32.5				
FEBRUARY		31.8	31.7				
MARCH		37.4	44.8				
APRIL		59.2	56.2				
MAY		66.3	67.2				
JUNE		72.1	72.6				
JULY		76.4	78.0				
AUGUST	72.0	75.3	74.1				
SEPTEMBER	67.4	71.3					
OCTOBER	54.3	62.8					
NOVEMBER	46.4	50.4					
DECEMBER	40.4	39.8					
TOTAL	56.1	56.2					

Fig. 2. List of accounts and typical cards kept as permanent record of plant services



Synthetic Rubber Production Program Speeded by Steam Generating Units Equipped with LJUNGSTROM AIR PREHEATERS

Two typical steam generating units designed for refineries which are making butadiene are illustrated above, each equipped with a Ljungstrom Air Preheater. Furnace No. 1 has a capacity of 300,000 lb. of steam per hr. Gases enter the preheater at 735 deg. F., leave at 380 deg., heating the combustion air to 532 deg. In No. 2 furnace, capacity of 350,000 lb. per hr., gases enter the preheater at 700 deg. F., leave at 390 deg., heating combustion air to 550 deg.

• • •

The report of the Baruch Rubber Survey Committee highlights the call for more butadiene . . . the key factor in the production plan for some 370,000 tons of Buna S synthetic rubber.

But back of the need for more butadiene is a need for more process steam. New boiler plant capacity has to be added in a hurry, yet with the greatest possible conservation of steel.

Significantly, almost all of the power plants for this purpose now built or building are equipped with Ljungstrom Air Preheaters, despite a wide variation in other details of design. In addition, Ljungstroms are being used on the separately fired superheaters, and on the petroleum refining furnaces which help to supply the raw material.

Using a continuous regenerative counterflow principle, Ljungstrom Air Preheaters give the maximum transfer of heat from flue gas to combustion air with the minimum of equipment weight and size. In installation, they save steel and save time. In operation, they save fuel and contribute to continuity of service. For information on their application to any gas-to-air heat transfer problem, write:

THE

AIR PREHEATER

CORPORATION

Executive Offices: 60 East 42nd Street, New York, N. Y. • Plant: Wellsville, New York

OFF THE RECORD

(*Continued from page* 118)

when I asked him who analyzed these cards daily, he rather sheepishly replied, "My secretary." And when I asked him what qualifications she had for knowing whether the statements made on the job cards indicated that the employe had taken too much or too little time to complete his work, he had to reply that she hadn't any.

I fail to find an instance where anything concrete can be proven by such cards. In my opinion, the secret of economical maintenance is to know and understand the maintenance work and be thoroughly acquainted with the type of man that you have placed on each job. I have found that it is always better to be just a little under-manned than it is to be over-manned, and whether you are over or under can't be proven by job cards.

I was told one time by a man who was attempting to justify these cards in my mind, that by making an employe fill out a job card at the end of each day gave the employe the feeling that the management was constantly checking him. But I have found by actual experience on the job, that the management who depends upon the job card system for checking employes' work, has very little if any actual check. Certainly in my experience, the job card system has never served to improve the quality or quantity of the employes' work.

Occasionally I find plants using a machinery cost card system. When a piece of equipment is purchased new, the name of the equipment, the manufacturer, and its cost are listed on a card and every time a replacement part is purchased for this piece of equipment, the replacement part and its cost are recorded on the same card, the purpose of the card being chiefly to give a quick and accurate account of the cost of maintenance replacements to the piece of machinery, and frequently, where like-purpose pieces of equipment are installed by different manufacturers, the system serves as a check of the cost of replacements of one manufacturer's product against another.

The chief difficulty with this particular system regarding equipment is that I have never found the exact running time of each piece of equipment kept on the card. I found in one instance, that one manufacturer's article had been condemned in favor of a second, where a careful check of the situation showed that the first manufacturer's product had been in service many more hours than the second.

The second talking point for machinery cost cards is the fact that occasionally a piece of machinery will cost more to maintain over a period of a few years than its original worth, and it becomes advantageous to replace the entire unit. This can be spotted very easily on the cards. Since this is the exception rather than the rule, and since equipment more frequently becomes outdated with the development of new and more efficient equipment which cannot be determined on the cost card, it seems to me that the system is a bit too expensive as compared to the results which it produces.

Comparing Records

Our Purchasing Department keeps a record of articles purchased, by the name of the company, and we can nearly always determine the cost of replacement parts to machinery and equipment by scanning the Purchasing Department's records.

In large plants where large and expensive machinery is to be found, the system may have considerable merit, but in small plants where the machinery is small and numerous, it is my opinion that the information obtained from machinery cost cards is hardly worth the cost of keeping them.

Occasionally I find a person who boasts of his accomplishments as compared to another who went before him, and who is very anxious to open his records to prove how much better he is doing. This is not good business. It will not work. When comparing your records be sure to compare them with what is considered good engineering practice. In the final analysis that is the only thing that will stand up. The fact that someone else did not follow good engineering practice is history, and is a false base from which to compare present operations.

Records! Records! Records! How MANY records should I keep? How many records do I HONESTLY use effectively? I'll keep THEM and that's ALL!

Fuel Conservation Plan Developed

ENGINEERS for the Minneapolis-Honeywell Heat Regulator Co. have formulated the following rules for conserving heat used to maintain comfort in industrial plants which, in some cases where they have been put into effect, are reported to have resulted in as much as 30 per cent saving in fuel:

1. Maintain minimum permissible temperature in each section of an industrial building. For example, the office at 68 degrees, the machine room at 62, assembly room 65 and storage space 50. Remember that lower temperatures are more comfortable where manual labor is performed.

2. Maintain even temperatures in all occupied spaces and take frequent readings or recordings to be certain these temperatures are being maintained.

3. Turn off the heat in occupied spaces or reduce the temperature to just above 32 deg. where freezing would cause damage.

4. Disconnect unused lines and radiation.

5. Reduce temperatures at least 10 deg. when space is not being used, such as at night.

6. Use ventilating fans only when necessary and reduce the amount of outside air taken in to a practical minimum.

7. Insulate all doors and windows and keep them closed except to maintain a minimum of ventilation required for the workers' comfort.

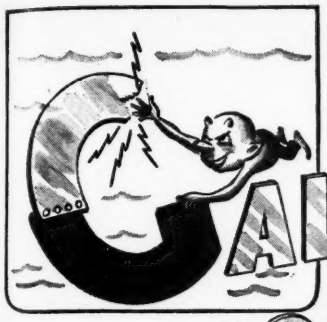
8. Remove anything which shields radiators, such as machines and cabinets, so there will be no retarding of the flow of heat.

9. Have a competent heating engineer survey the heating system and make any changes he recommends.

10. Employ a competent maintenance man to operate the heating system and make a complete survey of it at least once a month.

11. Solicit the cooperation of everyone in the building to save fuel by keeping windows and doors closed and by reporting overheating.

12. Control the temperature of hot water delivered to factory processes and washrooms at the minimum permissible.



GALVANIC CORROSION

OF DISSIMILAR METALS

And how milliampere Gremlins may be foiled at their own game

Today, dissimilar metals must frequently be used in more or less untried combinations. This is made necessary by metal shortages and urgent production needs.

Such combinations when exposed to liquids or moisture can result in serious galvanic corrosion. Therefore galvanic couples now merit much closer attention by plant and design engineers than was previously necessary.

Also, since its effects are not readily distinguished from those of the ordinary types of corrosion, it frequently is blamed for troubles it could never cause. Yet when really present, galvanic corrosion may be very serious.

Practices for controlling Galvanic Corrosion

1 Select combinations of metals as close together as possible in the Galvanic Series.

2 Avoid combinations where the area of the less noble material is relatively small. It is good practice to use the more noble metals for fastenings or other parts in equipment built largely of less corrosion resistant material.

3 Insulate dissimilar metals wherever practical. If complete insulation cannot be achieved, anything such as paint or plastic coatings at joints to increase the resistances of the circuit will help.

4 Keep dissimilar metals as far apart as possible. This rule applies even when the actual connection between the metals is made external to the corrosive liquid.

5 Apply coatings with caution. For example, when painting—do not paint the less noble material without also coating the more noble, otherwise greatly accelerated attack may be concentrated at imperfections in coatings on the less noble metal. *Keep such coatings in good repair.*

6 Prevent or limit aeration of the corrosive liquid as much as possible to sustain the polarizing effect of the hydrogen film which forms on bare cathodic surfaces.

7 If practical, add chemical inhibitors to the corrosion solution according to the nature of the solution to be inhibited.

8 Avoid joining materials well apart in the series by threaded connections, as the threads will probably deteriorate excessively. Brazed joints are preferred when practicable.

9 Whenever possible, install relatively small replaceable sections of the less noble material at joints and increase the thickness of the less noble material in such regions; for example, by using extra heavy wall nipples in piping or by attaching replaceable pads to critical surfaces.

10 Install pieces of bare zinc or steel to provide a counteracting galvanic protection effect to suppress galvanic corrosion.

•

INCO'S Technical Service is prepared to assist metal users in solving galvanic corrosion problems. Available data from INCO'S Corrosion Files for a particular combination of metals will be furnished wherever possible. Aid can also be extended in applying general principles to specific problems.

As a first step in securing INCO'S help on a specific corrosion problem, write for a copy of the Corrosion Data Work Sheet.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York, N. Y.

GALVANIC CORROSION *and* THE GALVANIC SERIES

Galvanic Corrosion is caused by contact or connection of unlike metals in a corrosive liquid. Because generation of electric current is associated with galvanic corrosion, the metals act like a galvanic cell and corrosion action may become more serious and more rapid than that fostered by the corrosive liquid acting on the metals separately. Such action may be prevented or minimized by using the Galvanic Series to guide the selection of metal combinations.

GALVANIC SERIES

Corroded End (anodic, or least noble)

Magnesium
Magnesium alloys

Zinc

Aluminum 2S

Cadmium

Aluminum 17ST

Steel or Iron
Cast Iron

Chromium-iron (active)

Ni-Resist

18-8 Stainless (active)
18-8-3 Stainless (active)

Lead-tin solders
Lead
Tin

Nickel (active)
Inconel (active)

Brasses
Copper
Bronzes
Copper-nickel alloys
Monel

Silver solder

Nickel (passive)
Inconel (passive)

Chromium-iron (passive)
18-8 Stainless (passive)
18-8-3 Stainless (passive)

Silver

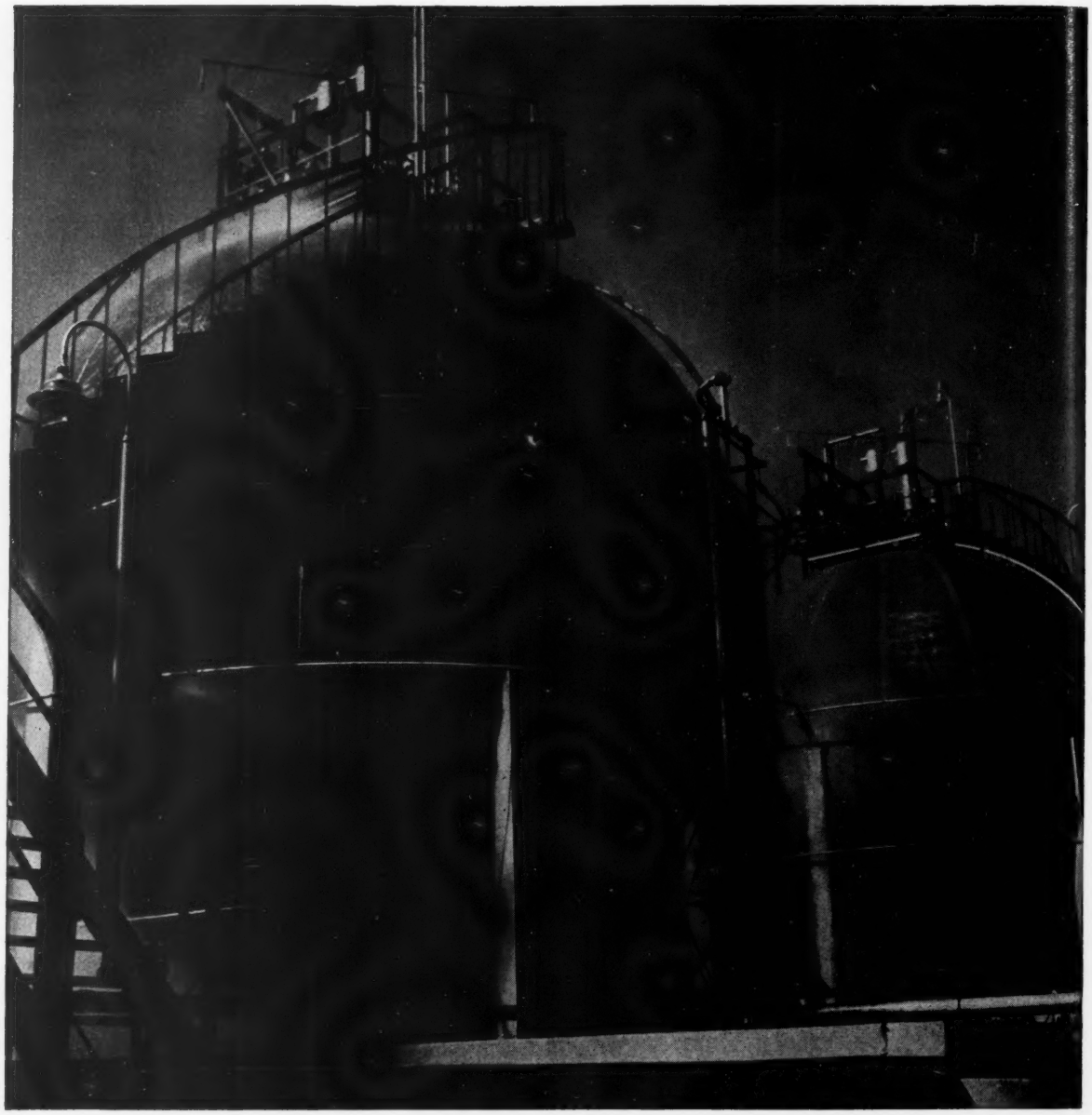
Graphite
Gold
Platinum

Protected End (cathodic, or most noble)

According to studies and practical experience from which the Series resulted, metals within a group have no strong tendency to produce galvanic corrosion of each other and therefore make relatively safe combinations unless the area of the less noble is markedly smaller.

The coupling of two metals from different groups and distant from each other in the list can result in galvanic, or accelerated corrosion of the less noble material. The farther apart the metals stand, the greater will be the galvanic tendency.

Although the arrangement of metals in the Series is based on results of experiments and practical experience involving many common corrosives, it cannot replace the need for tests when unusual corrosives are encountered or when other unusual conditions prevail that may cause major shifts of the relative positions of metals in the Series.



AMERICA'S WAR PRODUCTION DEPENDS ON TANKS LIKE THESE

Take a good look at these huge spherical tanks. Chances are your hose, your belts, your packings may come from them or from others just like them.

These are used for storing butadiene in the first of the synthetic plants operated by U. S. Rubber Company . . . a second will soon be in production.

Having worked in the field of synthetic rubber since 1921 we know what uses each of the five basic types of synthetic rubber is best suited for . . . Neoprene, Buna-S, Buna-N, Butyl and Thiokol . . . U. S. Rubber uses all five types . . . knows which one to select for the performance required . . . and how to compound the specific synthetic rubber for the specific task. This experience is important to you.

Our booklet on synthetic rubber will give you much valuable information. Send for your copy.

Mechanical Goods Division

UNITED STATES RUBBER COMPANY

ROCKEFELLER CENTER • NEW YORK

THE M. W. KELLOGG COMPANY

Fabricators and Erectors

of

COMPLETE PIPING SYSTEMS

for

HIGH PRESSURE — HIGH TEMPERATURE
PUBLIC UTILITY and MARINE POWER PLANTS

* * *

PROCESS PIPING FOR INDUSTRY

* * *

Heat Transfer Equipment for Industrial and Marine Power Plants

KELLOGG

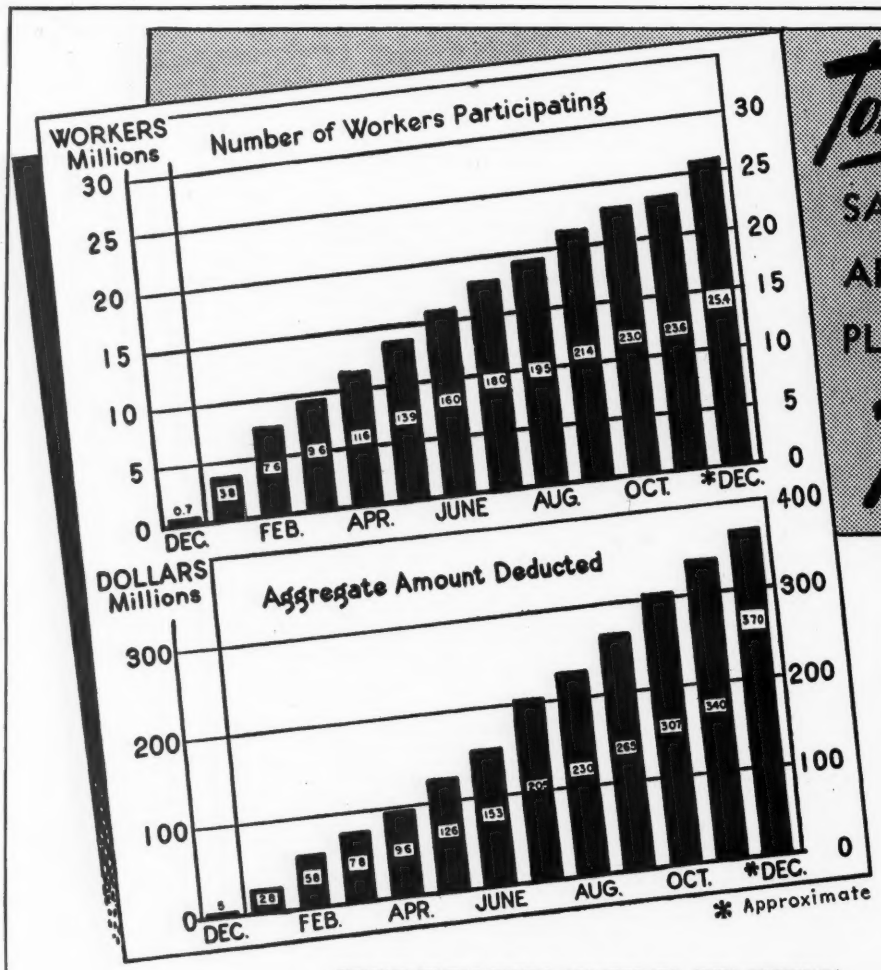
"Kellogarflex" Prefabricated Piping Systems • "Kellogweld" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units; Reforming, Dehydrogenation, Alkylation, Desulphurization, Thermal and Catalytic Polymerization Units • JUKK Processes for Lubricating Oil Plants. Plastic Refractories • Radial Brick Chimneys.

THE M. W. KELLOGG COMPANY · JERSEY CITY, NEW JERSEY · 225 BROADWAY, N. Y.

REPRESENTATIVES

LOS ANGELES: 689 SOUTH GRAND

TULSA: PHILTOWER BLDG.



Tomorrow's

SALES CURVES ARE BEING PLOTTED . . .

Today

THESE CHARTS SHOW ESTIMATED PARTICIPATION IN PAYROLL SAVINGS PLANS FOR WAR SAVINGS BONDS *(Members of Armed Forces Included Starting August 1942)*

STUDY THEM WITH AN EYE TO THE FUTURE!

There is more to these charts than meets the eye. Not seen, but clearly projected into the future, is the sales curve of tomorrow. Here is the thrilling story of over 25,000,000 American workers who are today voluntarily saving close to FOUR AND A HALF BILLION DOLLARS per year in War Bonds through the Payroll Savings Plan.

Think what this money will buy in the way of guns and tanks and planes for Victory today—*and mountains of brand new consumer goods tomorrow.* Remember, too, that War Bond money grows in value every year it is saved, until at maturity it returns $4 for every $3 invested!

Here indeed is a solid foundation for the peace-time business that will follow victory. At the same time, it is a real tribute to the voluntary American way of meeting emergencies that has seen us through every crisis in our history.

But there is still more to be done. As our armed forces continue to press the attack in all quarters of the globe, as war costs mount, so must the record of our savings keep pace.

Clearly, on charts like these, tomorrow's Victory —*and tomorrow's sales curves*—are being plotted today by 50,000,000 Americans who now hold WAR BONDS.

EVERYBODY EVERY PAYDAY AT LEAST 10%

Save with

War Savings Bonds

This space is a contribution to America's all-out war effort by

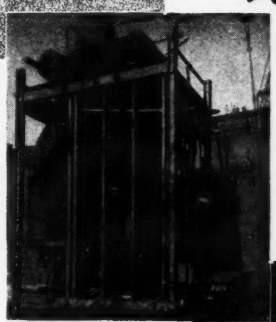
POWER PLANT ENGINEERING

Vogt PRODUCTS ARE

★ DESIGNED to RAISE
★ OPERATING STANDARDS and
★ LOWER YOUR COSTS

Drop Forged for Safety and Economy under the Most Trying Conditions

Valves, Fittings and Flanges by Vogt—the choice of operating men everywhere for safe and sure regulation of the high pressure and high temperature liquids and gases used in modern process work.



High Operating Efficiencies and Low Maintenance Costs

More steam per dollar of investment—because Vogt steam generating equipment is designed and built to fit in with specific operating conditions. Vogt boilers are available in bent tube types and straight tube, forged steel sectional header types for solid, liquid, or gaseous fuels, as desired. Three-drum types can be supplied to fit any conditions of restricted installation space.

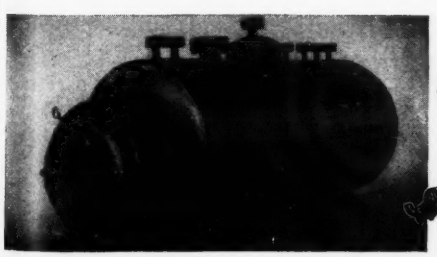
Meeting the Demands for Operating Security

Vogt has every facility for the fabrication of stills, towers, continuous rotary filters, filter presses, oil chilling machines, heat exchangers, etc., and these products are serving the petroleum industry around the world.

Vogt PRODUCTS

For Oil Refineries, Chemical Plants, Power Plants and Related Industries

HENRY VOGT MACHINE CO.
LOUISVILLE, KENTUCKY
NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS



To Combat Corrosion and Product Contamination

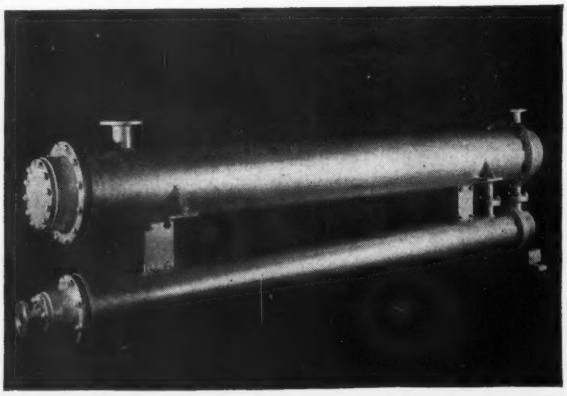
Process equipment made from special metals and alloys for the exacting service of the chemical plant is fabricated in our modern shops for many of the well known chemical companies.

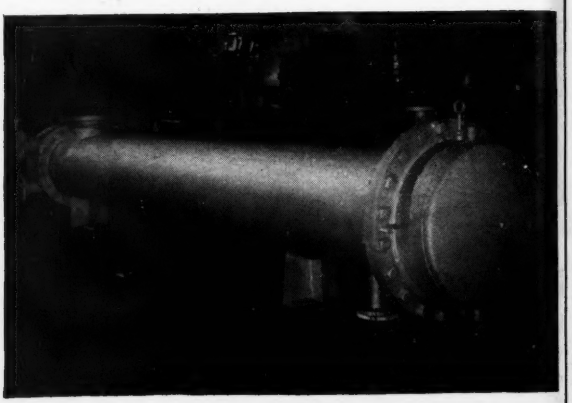
Steps Tonnage Up and Costs Down

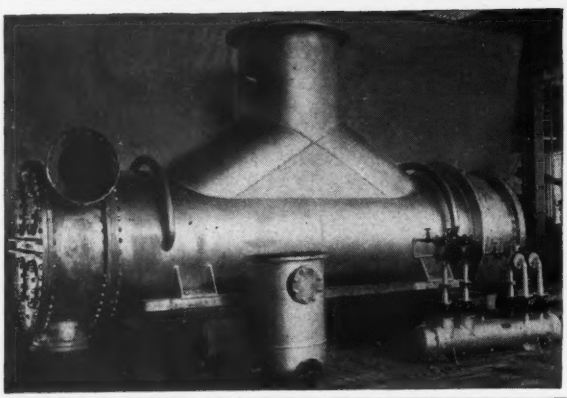
Our experience of more than 50 years in building profit-making ice and refrigerating machinery is at your command. We make complete units for ice and cold storage plants, packing plants, dairies, breweries, chemical plants, oil refineries, etc.

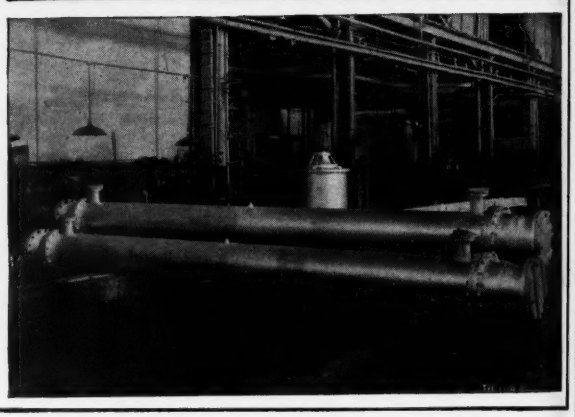
HEAT INTERCHANGE AND VACUUM EQUIPMENT

For Every Power Plant Need









Long the country's largest single purchaser of heat transfer equipment for the refineries, etc., which it designed and built for leading companies, Lummus four years ago began building its own. It did this in order to make available to its clients improved equipment of modern design and superior workmanship.

The services of Lummus engineering personnel and the facilities of the Lummus heat exchanger plant at Honesdale, Pennsylvania, are available to public utilities and industrial plants for the study of specific problems and the design of heat exchanger equipment to meet individual conditions.

★ SURFACE CONDENSERS
★ STEAM JET AIR PUMPS
★ BLEEDER HEATERS
★ BOILER BLOWDOWN HEAT EXCHANGERS
★ FUEL OIL HEATERS
★ LUBRICATING OIL COOLERS

LUMMUS

THE LUMMUS COMPANY • 420 Lexington Avenue, New York, N. Y.

DEPENDABILITY

For many years "Old Faithful" has been a byword for dependable performance. Once every hour, day in and day out, as far back as man can remember, this famous geyser in Yellowstone Park has spouted for four minutes. In this brief time ten to twelve thousand gallons of water rush forth, the column rising to an average height of 140 feet. Then the flow ceases abruptly, to reoccur an hour later.

Powell Valves, too, are famous for dependability in flow control. Through nearly a century, under ever-increasing pressures and temperatures, Powell Valves have been a byword for dependable performance in the power lines of industrial America.

The Wm. Powell Company

Dependable Valves Since 1846

Cincinnati, Ohio

Fig. 386 (Left)
200-pound Bronze Gate Valve with screwed ends, outside screw rising stem, screwed in yoke bonnet, bolted flanged packing gland and renewable hard bronze seat rings and taper wedge solid disc. Sizes ½" to 3", inclusive.

Fig. 375 (Left)
200-pound Bronze Gate Valve with screwed ends, union bonnet, inside screw rising stem and special hard bronze disc. Sizes ¼" to 3", incl.

Fig. 500 (Right)
125-pound Bronze Gate Valve with screwed ends and screwed-in bonnet. Sizes ¼" to ¾" equipped with taper wedge sold disc; sizes 1" to 3" with taper wedge double disc.

The POWELL Line includes Globe, Angle, Gate, Check, Relief, Y, Non-Return and other types of valves in bronze, iron, steel, pure metals and special alloys to meet Industry's demands for DEPENDABLE FLOW CONTROL EQUIPMENT.

POWELL VALVES

WAR CONDITIONS

DEMAND PACKINGS BE CONSERVED!

In the 50 years existence of this Company, never have Belmont Packings been in greater demand, more urgently needed.

Packings are important! They are essential not only in the production, but in the operation of guns and mobile equipment—tanks, planes, ships.

Materials used in the complete line of Belmont Packings come from far-off places—asbestos, flax, jute, rubber, lubricants. Supplies of these critical raw products have been restricted, by regulation, to war uses. In substance, demands and problems are great, the like of which the world has never seen before!

How can Belmont meet the situation? It must continue to work to capacity with tools available.

How can the user meet the situation? He can conserve the use of packings along the lines of the four suggestions below.

THE BELMONT PACKING & RUBBER CO. — BELMONT — PHILADELPHIA, U.S.A.

A—CONSERVE PACKINGS—When repacking, it may be found that a few rings of new packing inserted next to the gland may give added service. This will mean conservation of old packing retained in the stuffing box.

B—LUBRICATE MOVING PARTS—Keep rods, shafts and plungers thoroughly swabbed with oil or grease to alleviate frictional wear on packing. Where practicable, install oil lanterns.

C—CHOOSE SUBSTITUTE CONSTRUCTIONS—When material shortages make your desired type not instantly available, consult with your nearest Belmont distributor or with us for guidance on this question.

D—REFER TO THE BELMONT CATALOG—It's an invaluable packing guide of complete information on packings for all services . . . it contains informative charts; clearly illustrates and describes every Belmont packing; and suggests varied packing styles from which to choose a substitute packing, if necessary. Write on your Company letterhead for your copy.

There's a Belmont Packing for every service . . . Steam, Water, Oil, Gas, Air, Acid, Alkalis, and Ammonia. Forms include Rings, Coils, Spirals, Reels, Spools, Sheets, and Gaskets.

BELMONT PACKINGS

The Belmont Packing & Rubber Company

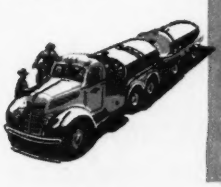
Butler and Sepviva Streets **Philadelphia, Penna.**

The Balance of Power!

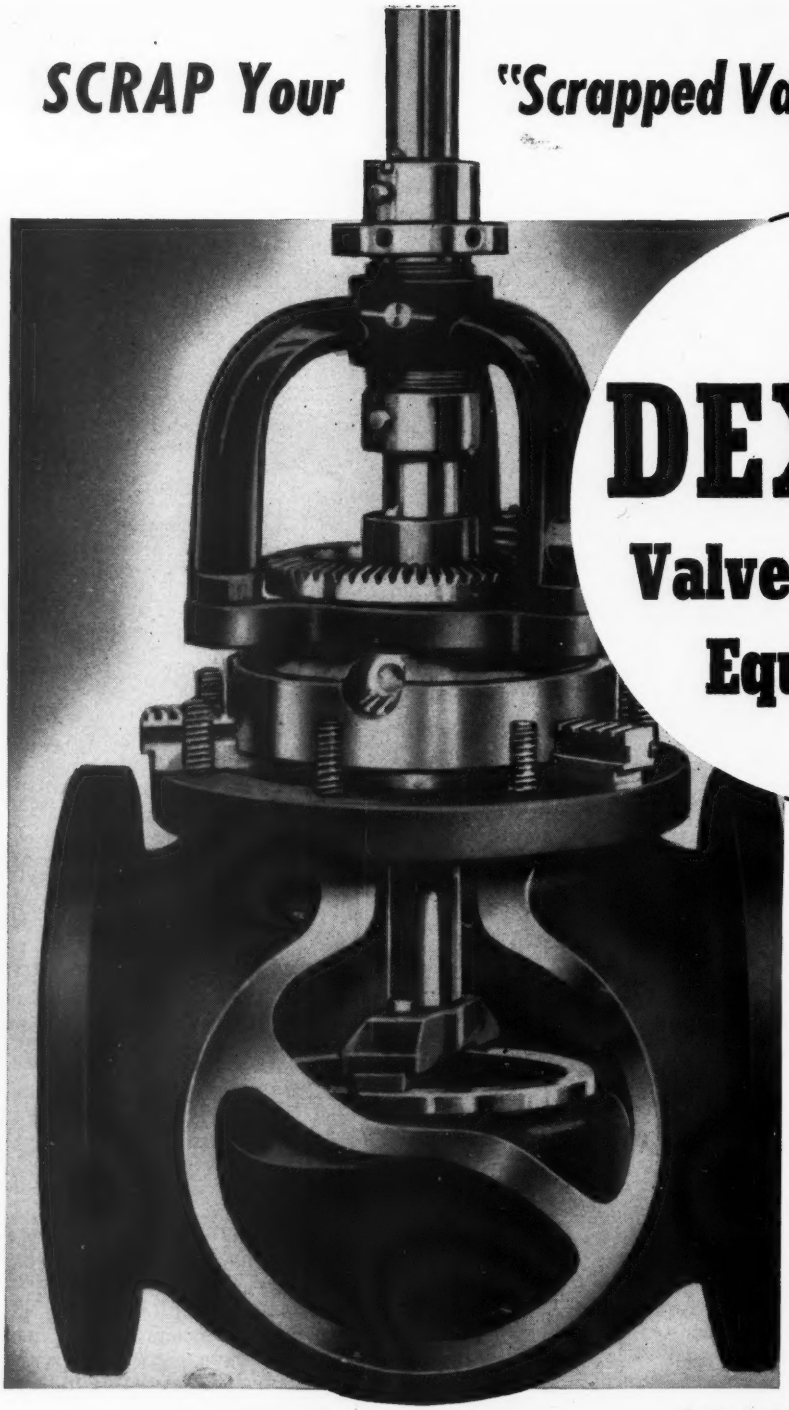
Ability to produce for ourselves and our allies is completely dependent on the generation of power—the energy that turns the wheels of industry. The common enemy of power is water-deposited scale. It must be removed, if boilers are to deliver their full quota of B.T.U.'s. The conventional practice for scale removal is a manual operation consuming much time. Chemistry has stepped in and now provides an efficient method that removes the scale in a few hours.

This is an industrial service developed by Dowell Incorporated, subsidiary of The Dow Chemical Company, with eleven years' experience in the chemical treatment of oil and gas wells. Dowell industrial chemical service uses chemical solutions for the disintegration and removal of deposits coating heat exchange surfaces. Precious time, manpower, equipment are saved. Thus chemistry is assisting industry in maintaining its "balance of power."

DOWELL INCORPORATED
Kennedy Bldg., Tulsa, Oklahoma
Subsidiary of The Dow Chemical Company



SCRAP Your "Scrapped Valve" Problems



with DEXTER Valve Reseating Equipment

Today, with new valves and parts so hard to obtain, it almost seems like a crime to scrap old valves. And it *is* a crime to scrap them, when they can be reconditioned — made as good as *new* — with Dexter Valve Reseating Equipment.

In just a short time, any mechanic using Dexter Valve Reseating Equipment can turn a leaky valve into a lucky valve, a wasteful valve into a highly *efficient* one by making a valve seat and disc or gate *absolutely tight.* And it makes no difference what kind of metal a valve is made of . . . Dexter Cutters are available for monel, stainless, stellite, bronze, brass.

It is *vital* to our country to preserve valves and conserve power . . . and it is very *economical* for your company, too. Send for further information about Dexter Valve Reseating Equipment, today.

CAPACITIES: *Globe valves, ¼" to 14"; Gate valves, 1½" to 48"; Pump valves, 1½" to 15".*

DEXTER Valve Reseating Machines

THE LEAVITT MACHINE COMPANY

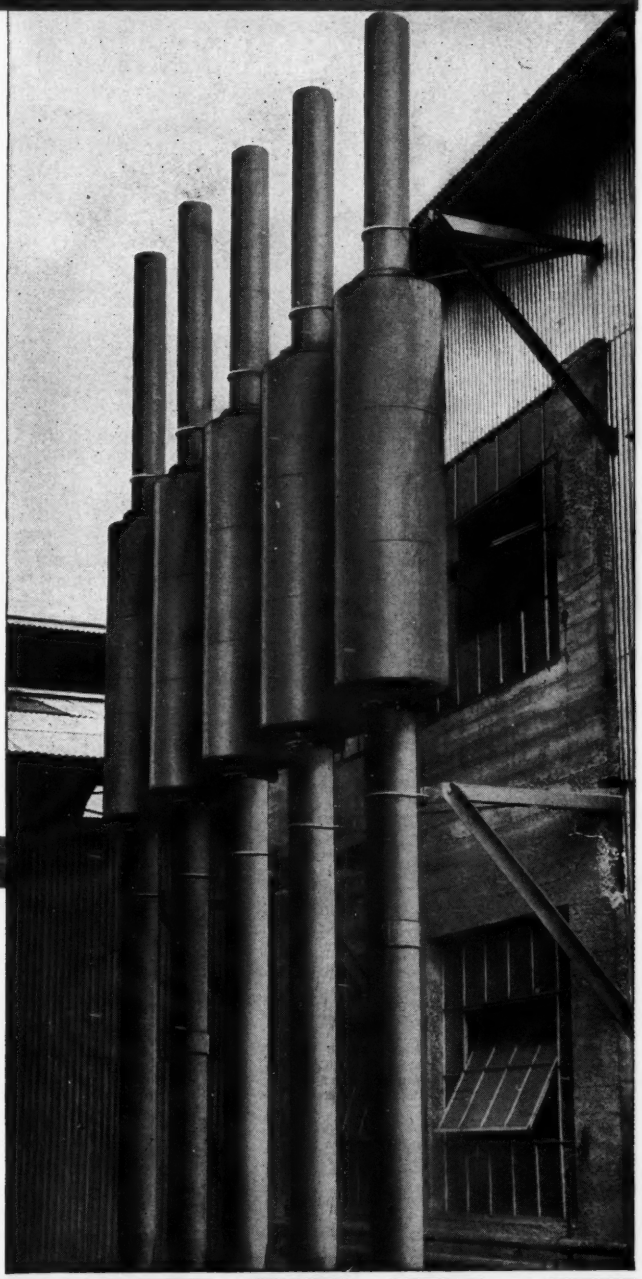
404 EAST RIVER ST., ORANGE, MASS.

A CORPS OF EXPERTS

AT YOUR SERVICE
(NO PRIORITY NEEDED)

Maxim Engineers are experts not only in the designing and building of silencing equipment but also in the solution of practical installation problems that occur in the field. Right now Maxim equipment is available only on high priority ratings, but the advice of the Maxim engineering department is yours for the asking . . . whether or not you have or can buy Maxim Silencers. If you are troubled with poor engine efficiency which you feel is due to any factor in the installation of your present exhaust or intake lines (with or without silencers), we think that we can probably help you.

Simply write to Maxim giving complete engine specifications, a sketch of your present hook-up, describing existing exhaust and intake piping arrangement in detail, and notes on what your difficulty seems to be.



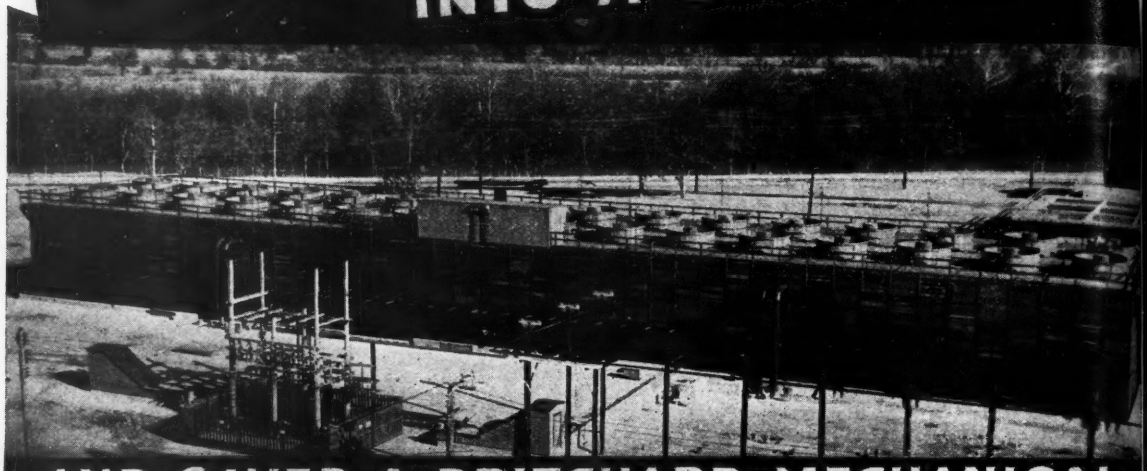
WASTE HEAT CONSERVATION

IMPORTANT Maxim's new Waste Heat Units make waste exhaust heat produce steam or hot water while at the same time providing efficient silencing for engine exhaust. This important development is discussed in Maxim Waste Heat Bulletins WH-100 and WH-103, available on request. The Maxim Silencer Company, 89 Homestead Ave., Hartford, Conn.

MAXIM

WARTIME ENGINEERING SERVICE

How COST CAPITALIZATION TURNED A HIGH BID INTO A LOW ONE



-AND SAVED A PRITCHARD MECHANICAL DRAFT BUYER- THOUSANDS OF DOLLARS

Why Pritchard Towers Save You Money

1. High Efficiency, Light Weight, Non-Corrosive Monel Fans. Pritchard fans are the heart of Pritchard tower efficiency and economy. Their superior design and construction saves tremendous amounts of horse power over a period of years. Blades have a special twist and taper that gives a steady, uniform air flow through the entire fan opening.

The use of non-corrosive sheet monel over a light, strong framework cuts weight to half that of cast alloy — ends corrosion and pitting troubles. Larger blades, and often fewer of them, move the required volume of air with less fan speed and less fan power. Pritchard fan drive design and fan housing design, particularly in induced draft towers, contribute further to fan efficiency and horsepower economy.

2. Low Pumping Head. Closed pipe water distribution through gravity sprinklers cuts down frictional resistance; saves pump power for lifting; sometimes even permits building higher towers without waste.

3. Liberal Size and Rating. Any "skimping" on capacity must be made up by an extra load on fans or tower efficiency will suffer. Pritchard towers are sized and rated to permit low air velocities and consequent lighter fan loads.

Further details on request. Write for them.

On a certain large mechanical draft cooling tower job not long ago the Pritchard *price* was $8000 high. But on a cost and operating capitalization over a period of five years the Pritchard tower showed a saving of several times that amount.

That is just one instance. There have been many others where Pritchard towers, because of their *operating economy*, have made first cost of secondary importance.

If you will purchase mechanical draft equipment on a cost capitalization basis, Pritchard towers will almost invariably save you money. Read the reasons why in column on left. Get Pritchard figures before you buy.

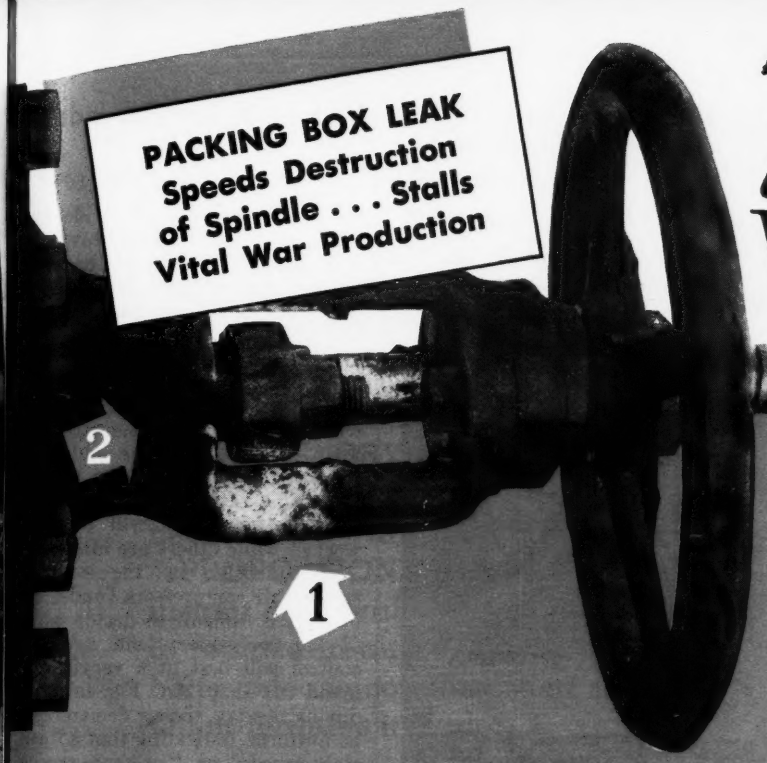
J. F. PRITCHARD and COMPANY
FIDELITY BUILDING KANSAS CITY, MO.

Branch Offices in Tulsa, Okla.; Houston, Texas; Atlanta, Ga.; Chicago, Ill.; Pittsburgh, Pa.; New York City

PRITCHARD

Atmospheric and Mechanical Draft

WATER COOLING TOWERS



Prevent Valve Failure *before it starts!*

A neglected leak in the packing box of the valve illustrated corroded the spindle so badly it had to be replaced.

The crusted scale (1) indicates that the leak was apparent for a long time. It is also evident that the gland has been tightened to the limit (2) by someone who believed he was checking the leak by compressing the packing. Instead, the packing was simply jammed into a hard, dry mass.

While the spindle was being replaced, it was necessary to close the main steam line and interrupt production in a plant buzzing with war work.

Waste of production hours through preventable valve failure is inexcusable today, since delay in the delivery of war materiel may eventually spell defeat for our armed forces. Equally serious is the waste of critical metals by needless destruction of valve parts. Such waste can be effectively controlled by an adequate program of valve conservation.

Make sure your valves are inspected regularly. Repair or replace worn parts before a valve destroys itself. Instruct maintenance workers thoroughly. Select valves for new installations carefully; install them properly.

Jenkins engineers will provide any assistance you need for improving your system of valve conservation upon receipt of details of present valve problems.

Jenkins Bros., 80 White St., New York, N. Y.; Bridgeport, Conn.; Atlanta, Ga.; Boston, Mass.; Philadelphia, Pa.; Chicago, Ill. Jenkins Bros., Ltd., Montreal; London, England.

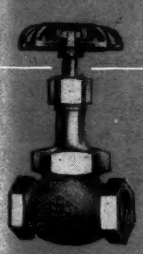
Packing Box Leaks are Easily Corrected by Proper Maintenance

Frequent inspection will reveal the tell-tale drip where the stem enters the packing box, which indicates faulty packing. First, tighten packing box by applying ordinary effort to gland nuts. Then if leak continues, repack valve.

When repacking, remove all old packing, and replace with new material of the proper type. Leaks often result from wrong packing.

If valves are used infrequently, or if internal conditions are unfavorable, it is advisable to keep a live load on the packing. Steel springs with two or three coils, installed between the packing nuts and gland (see 3), will keep packing compressed and compensate for varying conditions. Packing box leaks are just as troublesome in small valves as in large. Excessive tightening of the packing nut will not remedy the condition when repacking is necessary, and may damage the packing nut.

Smooth spindles are also important to prevent leaks and preserve the life of the packing. Keep spindles clean and protect them from scratching and scoring.



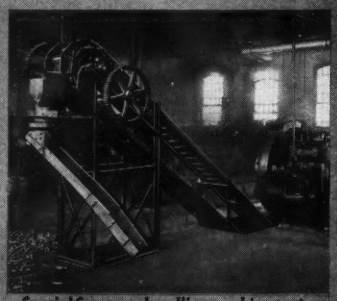
JENKINS VALVES

SINCE 1864

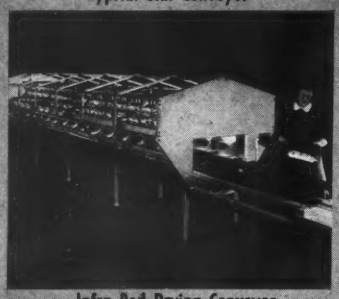
For every industrial, engineering, marine and power plant service . . . in Bronze, Iron, Cast Steel and Corrosion-Resisting Alloys . . . 125 to 600 lbs. pressure.

In time of ~~Peace~~ WAR prepare for ~~War~~ PEACE

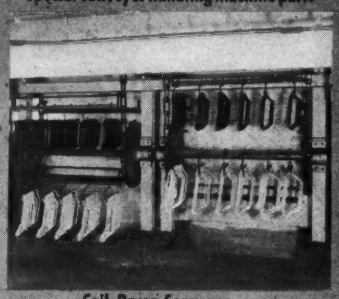
Typical Slat Conveyor



Special Conveyor handling machine parts



Infra-Red Drying Conveyor



Coil Dryer Conveyor

George Washington's advice is good even in reverse. It's none too soon to think of preparing to help meet the huge coming demand for peace-time goods. Why not now, while time permits, let Gifford-Wood plan with you to develop a material handling system that will enable you to compete successfully with others seeking the same business you will want?

There's real help along these lines available in the G-W organization. With unmatched experience in planning equipment and layouts, with many standard designs that are readily adaptable to special conditions, with an engineering development staff organized to tackle tomorrow's jobs as well as today's, G-W can relieve your busy engineers by working with them so you'll not lose months waiting for reconversion when that happy need arises.

While G-W shops are busy turning out war-time equipment, the engineering staff is adequate to give thought to the tomorrows. As a first step, you might look through G-W Catalog No. 200-E, a 125-page idea book on elevating and conveying equipment for handling bulk and packaged materials as well as parts in process of manufacture. A request on your business letterhead will speed a copy to you.

CONVERTED TO COAL? If not, let G-W engineers show you how to convert quickly for little money.

DRYING AND BAKING METAL FINISHES? If you still use ovens, let G-W show you how to cut production time 75% and space 50% with an Infra-Red system.

GIFFORD-WOOD CO.

FOUNDED 1814

420 Lexington Avenue, New York — **HUDSON, N. Y.** — 565 W. Washington Street, Chicago

Ash Spouts • Barge Unloading • Bins • Boiler House Equipment • Buckets • Bunkers • Carriers • Chutes
Conveyors • Crushers • Elevators • Feeders • Gates • Ground Storage Systems • Hoists • Hoppers
Infra-Red Drying Systems • Screens • Silo Storage Plants • Tanks • Weigh Larries

3685

Victory in the Grounded Air

(*Continued from page* 86)

ordinated with the old, wide fluctuations in air pressure, heavy current surges to motors, and necessity for continual adjustment of independent control mechanisms, will likely result.

Under one coordinated control, however, an evenly regulated and uniform air pressure is maintained with minimum power consumption. Such controls have the additional advantage of flexibility to balance the load evenly between compressors, so that none will be overworked while others are idle.

Frequently, in the case of smaller air compressors (under 100 hp.), it is difficult to decide which of the two conventional types of control will best fit a varying demand for shop air. For instance, during the day, the air demand may be uniform, indicating that a "constant-speed" or "pressure-regulator" type of control will prove most economical.

During off hours, nights, Sundays, etc., the air demand is intermittent and infrequent, and it would obviously be wasteful of power and equipment life to let the compressor idle (with motor running) for 50 min. of each hour, while actually compressing air only 10 min. It is at once apparent that the latter conditions demand an automatic start-and-stop control.

Until recently no standard control arrangement, meeting both these requirements, was available. Now it is commonplace, being available on some makes of compressors even on fractional horsepower sizes. It is known as dual control. To switch from one method of control to the other, requires merely changing the position of a selector switch.

Dual control can generally be applied to compressors operating under either of the other types of control. It is so inexpensive that, where conditions warrant, it will save its cost in a matter of weeks.

Today we hear, "Airplanes will win the war," "Food will win the war," "Machine tools will win the war," "Man-power will win the war." To these let us add "Conservation of power, materials, man-hours, and money, in the use of compressed air, will help win the war." While none of these factors alone will do the job, each constitutes one of the fibers being woven into the line that will haul down the Axis flag and raise the Allied banner of victory.

%PROPORTIONEERS, INC.%

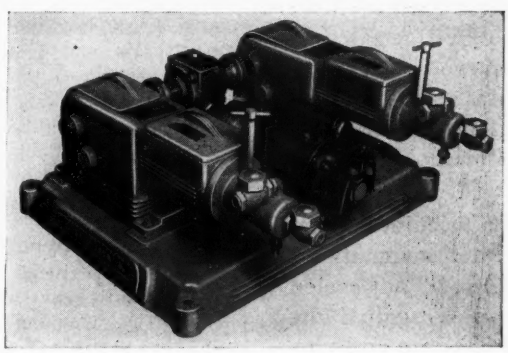
SPECIALIZED ENGINEERING
ON PROPORTIONING PROBLEMS

FOR INSTANCE . . .

CASE HISTORY NO. 8. At a certain naval base, internal boiler treatment to each of four boilers was necessary — and continual operation imperative. A %PROPORTIONEERS% Quadruplex Adjust-O-Feeder won instant approval because each pump is a complete unit—to replace in any assembly you need only remove four bolts, release coupling, and slide spare pump into place. Other features include:

1. Straight through drive shaft design permits mounting up to 8 units, operated from a single central motor (duplex design illustrated).

2. Available in either plunger or diaphragm types. Plunger units (0 to 10 g.p.h.) with Bakelite or plastic cylinders (0 to 200 lbs.), with stainless or iron (0 to 1000 lbs.) are equipped with %PROPORTIONEERS% fluid sealed stuffing gland for hard-to-handle and corrosive fluids; and built-in ball type checks. Diaphragm units (0 to 7½ g.p.h.; 0 to 100 lbs.) are available with neoprene pre-formed reinforced diaphragms—no stuffing gland—plastic diaphragm heads—built-in suction and discharge valves with sight feed domes.



Duplex Midget Adjust-O-Feeder Proportioning Pump of Plunger Type. Available with from 1 to 8 units driven from a single central motor. See Feature No. 1, above.

3. Micrometer stroke adjustment through neutralizing eccentrics.

4. Fully enclosed frame presents pleasing appearance, protects moving parts, and eliminates necessity of guards.

Complete engineering details forwarded upon receipt of full information about your problem. Address—

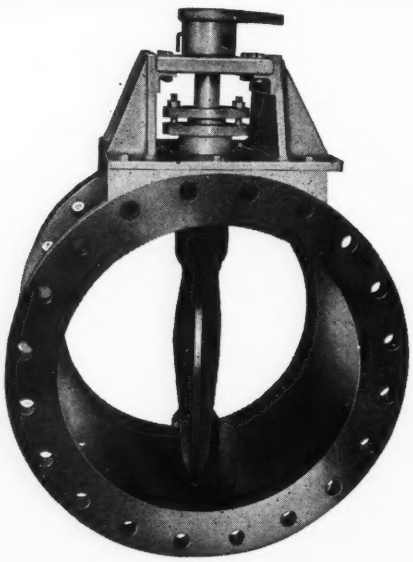
%PROPORTIONEERS, INC.%

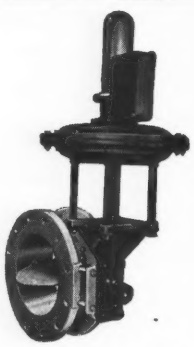
46 CODDING STREET, PROVIDENCE, R. I.

PARTICULARLY well adapted for WATER LINES

Low Pressure Loss When Open

Standard 24-inch 125 lb. iron valve with ball crank arm for connection to extended reach rod. Sleeve bearing lubricated stuffing box with cage. When the vane is fully open, flow conditions are similar to those produced in two Venturi Tubes.





Air diaphragm motor for automatic operation—15 pounds pressure.

15 to 900 P. S. I.

The pressure loss in a wide open R-S Butterfly Valve is less than in most conventional types of wedge gates. In fact, the streamlined vane is a Venturi maker and is practically self-cleaning. Any member of the R-S Butterfly Valve line will sting the maintenance bill every time.

These valves are accurately machined and are either manually or automatically controlled. The beveled vane seats at an angle against the valve body. There is a size and type for practically any service condition.

SUBSTITUTE METALS—R-S has developed pressure iron castings for resistance against heat, abrasion and corrosion. They replace vital victory production metals and are considerably lower in price. For instance, R-S "A" Metal, a tough dense metal of high endurance, is used in applications where hard wear and severe stresses are encountered. Has a tensile up to 50,000 p. s. i. and is readily machinable. Write for detailed information and the R-S Butterfly Valve Catalog.

VALVE DIVISION

R-S PRODUCTS CORPORATION

4535 Germantown Avenue • Philadelphia, Penna.

R-S Streamlined BUTTERFLY VALVES

Where a Short Is Not a Short

(*Continued from page* 114)

With over three parallel lines in use a separate unit may be employed with each two lines.

In addition to the examples shown the principle may be applied in conjunction with polyphase systems.

Besides approaching a nearly fool-proof system of transmission wherein shorts neither disrupt nor alter destination potentials the arrangements may be further characterized:

Normally all branches are in use, keeping losses low.

Main line overloads have no unbalancing effect upon the transmission circuit or auxiliary units. Branch short circuits lose their "punch" upon occurrence and auxiliary units complete the action of relay.

More than one synchronized input may be fed to the branches through similar transformer and auxiliary unit combinations. More than one output may be similarly tapped from the branches.

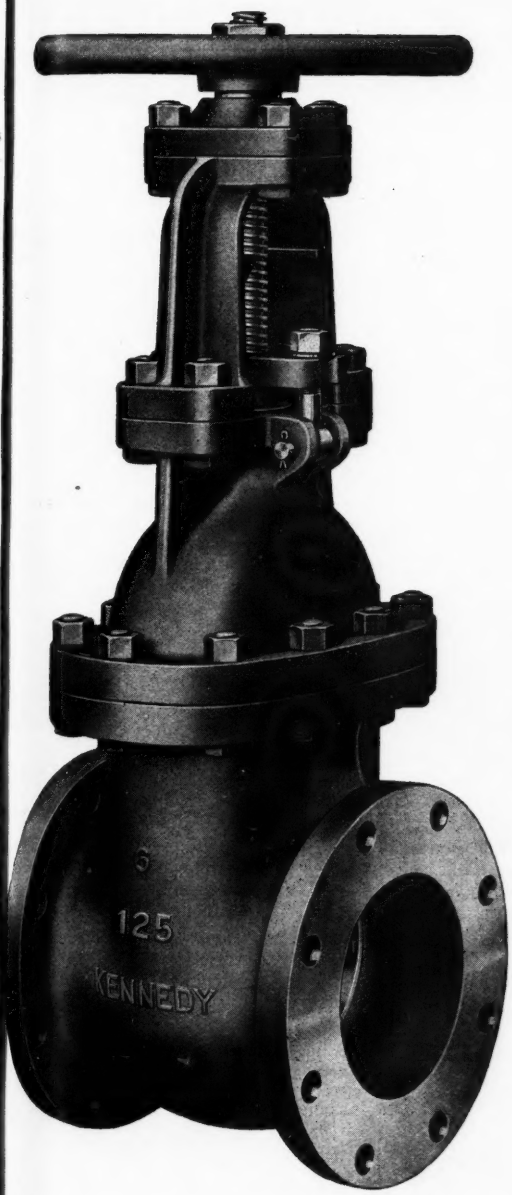
For the purpose of isolating disturbances, branches may be run for predetermined distances, and may be reunited, tapped and resplit again as often as consistent with costs and losses. All such units may be alike regardless of number.

In the type relay represented, where light loads permit the use of contacts only, actions are completely automatic; first in operation and second in resetting upon cessation of current flow.

Barring expense, circuits are applicable to heavy as well as light loads, by utilizing latches and switches in place of contacts. Relative results are obtained by the use of additional auxiliary mechanisms.

Induction relays have their relative place as to applicability, the diagrams shown being demonstrative of differential relay action. Protection is also automatically afforded against transformer shorts.

IN THE DISCUSSION of a paper at last annual meeting of the A.S.M.E. it was stated that an 18 per cent increase in capacity of an Otto-cycle engine with large clearance volumes and high residual-gas temperatures could be obtained by the employment of proper scavenging methods.



• RELIABILITY
• STRENGTH
• ECONOMY
• SAFETY

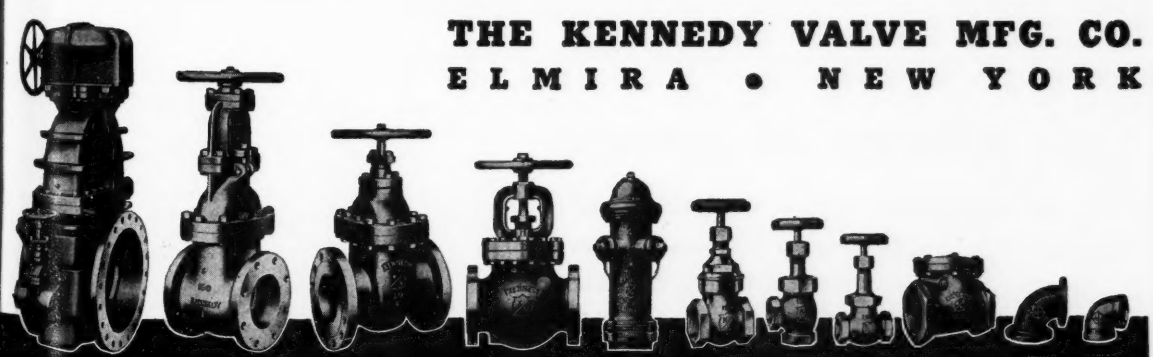
. . . characteristics of every **KENNEDY** *valve*

Kennedy Valves are reliable because of their simple, sturdy and effective operating mechanisms. Many of these mechanisms were originated by Kennedy, and have proven their effectiveness in thousands of installations.

These valves are economical because of their durability which has been demonstrated by decades of service in many installations without maintenance expense.

Their generous proportions of all parts, together with high-quality, high-tensile-strength metal, assure ample strength and complete safety. You are always safe with Kennedy "Extra Value" Valves.

THE KENNEDY VALVE MFG. CO.
ELMIRA • NEW YORK



KENNEDY *valves . . . pipe fittings . . . fire hydrants*

"Never touch metal to a Gauge Glass"

That's a first rule taught every power plant apprentice—a super legend, like strap oil, left-handed monkey wrenches and printers' type lice. To cut glass, you scratch it. Clean the inside of a gauge glass with a swab on the end of a wire and almost surely you'll scratch it. The scratch may be invisible, but reinstall the glass and turn on the pressure—bang!—another gauge glass blown to smithereens!

Any gauge glass is weakened if it's scratched. But, *unscratched*, PYREX Gauge Glasses last longer than other glasses. That's partly because they are made far stronger than necessary to withstand ordinary plant pressures, and partly because the glass from which they are made is highly resistant to corrosion. In fact, it is so inert to all acids except hydrofluoric, that it has been widely adopted for piping by the chemical industry.

And whether dimly or brightly lighted, PYREX Broad Red Line Gauge Glasses have the added advantage of being easier to read, from a distance. That's a safety feature, as you know if you've been near a glass when it blew. It's an efficiency feature, too—a step-saver and a time-saver.

Next time you call your jobber, specify PYREX Broad Red Line Gauge Glasses.

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works, Corning N. Y.

CORNING Glass Works Corning, New York

Pyrex Gauge-Glasses

CHANGE OF ADDRESS

To avoid missing an issue or paying for forwarding postage be sure to send a change of address to our office. Changes received by the 20th of the month can be made effective for following month's issue.

POWER PLANT ENGINEERING

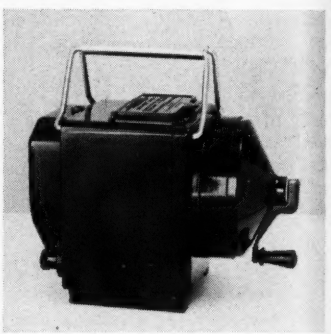
NEW EQUIPMENT

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING

"Megger" Insulation Tester

JAMES G. BIDDLE Co., Philadelphia, Pa., announce that they are now building the first U. S.-made "Megger" instruments for testing electrical insulation resistance and that they expect to be in full production by about June of this year. These are being built in a new factory in Philadelphia from raw materials and a few fabricated parts.

These new "Megger" testers are of the hand-generator and direct-reading ohmeter type and the same general design as the Biddle "Meg" and "Super-Meg" insulation testers. They are housed in molded cases of high-impact-strength plastic material. All joints are dust-proof.



The direct-reading true ohmeter indicates insulation resistance by pointer deflection. There are no keys to press or dials to adjust and the accuracy is independent of the speed of turning the hand cranked generator. The hand-cranked generator is instantly available for use anytime, anywhere. No battery or any other replacement parts are needed and no reliance need be placed on any outside source of current.

By special arrangement with the original makers of the "Megger" instruments, the new unit carries the U. S. registered trade mark name "Megger."

Improved Diffusion of Cement Mixtures

TO IMPROVE the dispersion of cement particles in a Portland cement mix, thus automatically permitting reduction of water ratio and improving the compressive strength characteristics of concrete, Santorized Trimix Liquid has been announced by L. Sonneborn Sons, Inc., New York, N. Y. It is claimed that such results are due to the application of the principle of greater wetting by means of additives having great surface activity and that these results are achieved without in any way interfering with the normal hydration cycle of Portland cement.

Advantages claimed for this method are reduction of up to 20 percent of the normal volume of gaging water and greater workability of the mortar. Slump tests, it is stated, show that when Santorized Trimix is added to the gaging water in proper proportions, the slump of a normal 1-2 mix ranges from 6 to

WeldELLS have everything ★

Every WeldELL can pass this test!

YES, every WeldELL* can pass this test for true circularity—or any other test for dimensional accuracy. A number of steps in their production contribute to this uniform accuracy, and as a final precaution every fitting is given a special truing operation to bring it to exact size before machining bevels and lands.

Why do we go to all this extra trouble just to provide a little greater dimensional accuracy in a rugged thing like a welding fitting? The man who uses WeldELLS knows the answer to that question. He has found that the extra lengths to which we go to achieve greater accuracy pays dividends in time saved on the job—results in better and faster welding.

Check down the list of WeldELL features and you will find that WeldELLS and other Taylor Forge Welding Fittings give you the means of doing every job as *well* as it can be done—as *easily* as it can be done—as *economically* as it can be done.

TAYLOR FORGE & PIPE WORKS
General Offices and Works: Chicago, P.O. Box 485
New York Offices 50 Church Street
Philadelphia Office: Broad Street Station Building

★ No other fittings for pipe welding combine the features found in WeldELLS. In addition to extreme dimensional accuracy these features include:

- **Seamless**—greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement**—provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line** of Welding Fittings and Forged Steel Flanges in the world—insures complete service and undivided responsibility.

WeldELLS are only one of many Taylor Forge contributions to the war effort. For example: huge Rolled Steel Rings that are an important part of U. S. tanks now in action.

* *WeldELLS and many other Taylor Forge Products are produced in Byers Genuine Wrought Iron.*

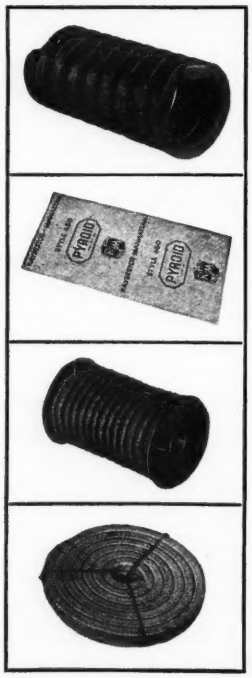
R/M PACKINGS

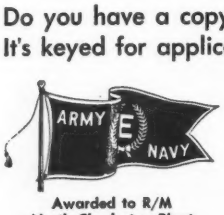
KNOW IT'S A CONFINING LIFE

It wouldn't do for Gargantua the Great to be on the loose, so he's confined to a specially built cage. It wouldn't do for steam, oil, fuel, or air to "get out of line," either. So industry uses R/M packings . . . as confining as a cage when it comes to holding materials in line.

Today's higher pressures put an added strain on packing, but R/M packings are equal to the task. R/M engineers are at it early and late, improving the sealing quality of R/M products. Army-Navy "E" awards aren't given lightly. They're a mark of merit in production for war.

Do you have a copy of the R/M catalog? It's keyed for applications, illustrated, and indexed as to materials and types. Get a copy from your R/M distributor, or write us direct.





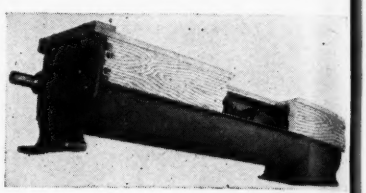
Awarded to R/M
North Charleston Plant

INDUSTRIAL SALES DIVISION
RAYBESTOS-MANHATTAN, INC.
MANHEIM, PA.
BRIDGEPORT, CONN. NORTH CHARLESTON, S. C. PASSAIC, N. J.
Makers of Packings for Every Industrial Use

7 in., as compared to 2½ in. with the same amount of plain gaging water. Higher strength by lowering of evaporation, resulting in more thorough curing; greater homogeneity; elimination of water segregation; greater water tightness, durability and less shrinkage, are claimed as a result of addition of Trimix.

Screw Conveyor Trough

LINK-BELT Co., 2410 W. 18th St., Chicago, Ill. announce that they have developed a screw conveyor trough that is made of a combination of steel trough bottom, wooden sides, and wooden cover board, lag-screwed together to form a complete, tight enclosure for the screw and the material it conveys. A substantial percentage of steel is saved compared to the all-steel trough and cover plate heretofore furnished.



A new combination wood and steel trough is adapted to all standard screw conveyor fittings; will readily connect with existing steel trough; and can be shipped with sides and bottom assembled.

The curved bottom will be made of steel no heavier than No. 10 gage, and has the added advantage of being removable by unscrewing of the lag screw securing it to wooden trough sides, thus facilitating cleaning and replacement.

PX-5 Black Baking Varnish

SYNTHITE PX-5 Black Baking Varnish is one of the newer and outstanding polymerizing varnishes developed during the past year by the John C. Dolph Co., 168 Emmett St., Newark, N. J. It is especially recommended for use on stationary and revolving units constructed with Class "B" insulating materials. It possesses the essential bonding properties which will hold modern types of magnet wire and insulating materials intact under the terrific centrifugal force developed by high speed windings.

Synthite PX-5 Black Varnish cures by heat induced chemical polymerization which solidifies the entire mass of varnish in the deepest winding voids or spaces. This curing characteristic eliminates surface sealing which usually causes uncured varnish to remain in the interiors of windings. The degree of curing can be controlled by varying baking temperatures between 245 and 275 deg. F. and controlling baking hour cycles.

This varnish is recommended for use on flexible armature coils. When used on these types of motor windings, each application of varnish requires only from 1½ to 3 hr. baking depending upon the temperature and actual cross section or depth of armature coil construction.

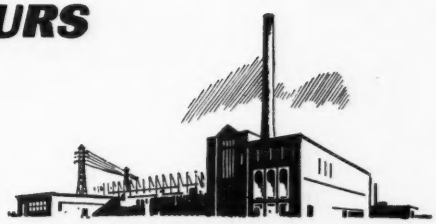
When used on all types of Class "A" insulated windings, this varnish imparts an excellent degree of toughness to cotton tape, paper, etc. When baked at ordinary oven temperatures and normal hour production cycles, organic covered winding leads remain flexible after bending at sharp angles.

GUARD THOSE VALVES OF YOURS

New valves will be *harder* to get—even if you work directly for the war effort.

There are not sufficient materials for valves—or wear resisting parts. Allocation will reduce, still further, amounts valve manufacturers have been able to obtain for lower ratings. And control is directing the uses to which all valves are shipped.

Too few of us have the feel of this war—yet. But, it is our belief that those who need continued operation of valves will be well advised to adopt conservation and substitution right now—as part of the price loyal citizens pay for a victorious war. It is no whit smarter to try to find "angles" by which materials needed for active war can be diverted to our plants than it is for a commander in the field to withhold an order to fire—to save his own hide.



READING-PRATT & CADY

MANUFACTURERS OF

R CAST STEEL VALVES P&C CO BRASS AND IRON VALVES

D'ESTE ENGINEERING SPECIALTIES

Reading, Pa., Atlanta, Boston, Chicago, Houston, Los Angeles, New York, Philadelphia, Pittsburgh, San Francisco

A DIVISION OF AMERICAN CHAIN & CABLE COMPANY, INC., BRIDGEPORT, CONNECTICUT

Working Side by Side FOR VICTORY

Old and New DART UNIONS

There is no "retiring age" for a Dart Union. If there is important work to be done, even though a Dart has seen *plenty* of service already, it can still see plenty *more*. And give tight-joint performance, too.

In a nutshell, here is the explanation of how Dart Unions can pay extra dividends in trouble-free performance and long life. Matched bronze seats, precision machined and ground to accurate "true-ball" surfaces make it possible for Darts to be used many times. Nuts and bodies made of heavy air refined malleable iron give Darts their ability to resist rough handling and pipe strains.

It is common sense and good patriotism to search out your plant for your old Darts and put them back to work. It is sound and far-sighted judgment to see your distributor now for *new* Darts, if you need them.

DART UNIONS

E. M. DART MFG. CO., Providence, R. I.

Sponge Rubber Gasket

ANOTHER new development, the creation of a sponge rubber gasket covered with a smooth coating of natural rubber or Ameripol synthetic rubber by the extrusion process is announced by The B. F. Goodrich Co., Akron, Ohio.

The new type gaskets are now being used only in products of war, mainly airplanes and tanks, where they are proving their value as a sealing member in severe service. After the war, this new type gasket is expected to find wide use on refrigerators, automobiles and other products.

When made with a covering of Ameripol, the new gasket is said to withstand the destructive action of oils and greases which have so often spelled destruction of refrigerator door gaskets made of natural rubber. The ability of Ameripol synthetic rubber to withstand extremely low temperatures also will make the new development especially valuable in the refrigeration industry.

The gasket has a much lower permanent set that the tubular type heretofore used on refrigerators and automobiles, and is as soft and compresses as well as the older type.

In the new process sponge rubber filler used is molded in slab form, slit into strips and fed through a special extruding machine to obtain the smooth covering which varies in thickness according to the customer's specifications. It is available in round, square and rectangular shapes, and is most practical at present in dimensions not smaller than ¼ in. nor larger than 1½ in. Maximum production length is 12 ft., but the product can be spliced to any desired length with the connecting points barely detectable. It can also be produced, where necessary, with a lip for attachment.

Control for Resistance Welding of Aluminum

GREATLY simplified construction is one of several important features of a new electronic capacitor discharge resistance welding control announced by the General Electric Co., Schenectady, N. Y., for the resistance welding of aluminum. This construction not only eliminates much vital material but facilitates thorough inspection and servicing.

Aluminum has low resistance and high heat conductivity. This control provides the very high currents and short welding time required for the satisfactory resistance welding of this metal.

The control consists of a charging circuit, a discharge circuit, control station, Pyranol capacitors, and sequence control. All this equipment is mounted in one cabinet-type, G-E industrial control enclosure with full-length front doors and removable rear covers. The enclosure is ventilated by filtered air which, drawn in by a blower, creates a positive pressure within the cabinet. The

STANDARD OIL ANNOUNCES

NEW Stanobar GREASE

For easier handling in grease guns ...longer life in anti-friction bearings

A war-bred grease for wartime jobs. Today's production pace demanded this new type grease. Longer hours of operation alone call for a more stable grease to resist heat and oxidation, while the need for more frequent lubrication of bearings makes an easily handled gun grease an asset.

Stanobar brings you both these advantages. It's a smooth (not fibrous) type grease. It contains inhibitors which reduce oxidation of both the soaps and oil in Stanobar. That means less cleaning of bearings and less labor and lubricant required to flush out old grease.

Stanobar resists thinning out when worked—that helps reduce leakage. It may also enable you to replace two or three grades of grease you are now using with this one grade of Stanobar.

Let a Standard Lubrication Engineer explain some of the other advantages of new Stanobar—and help you make a test. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago, Illinois, for the Engineer nearest you. In Nebraska, write Standard Oil Company of Nebraska at Omaha.

CHECK THESE ADVANTAGES OF NEW STANOBAR GREASE

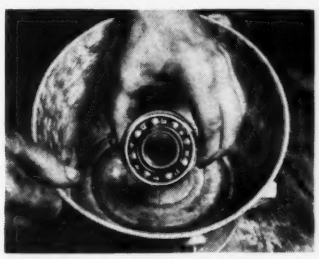
- ... Easily handled in grease gun or pressure system.
- ... Resists thinning-out when worked.
- ... Does not oxidize and form deposits.

How to service ball and roller bearings. Proper packing of bearings after inspection is highly important. Bearings equipped with pressure fittings are sometimes replaced dry and filled with a grease gun, but a careful, hand-packed grease job is well worth the little extra time it may take. The illustrations at the right point out some of the steps to take.

OIL IS AMMUNITION...USE IT WISELY

Clean motor and bearing housing before removing bearing.

Remove bearing wash it in kerosene, and dry thoroughly with a clean cloth.



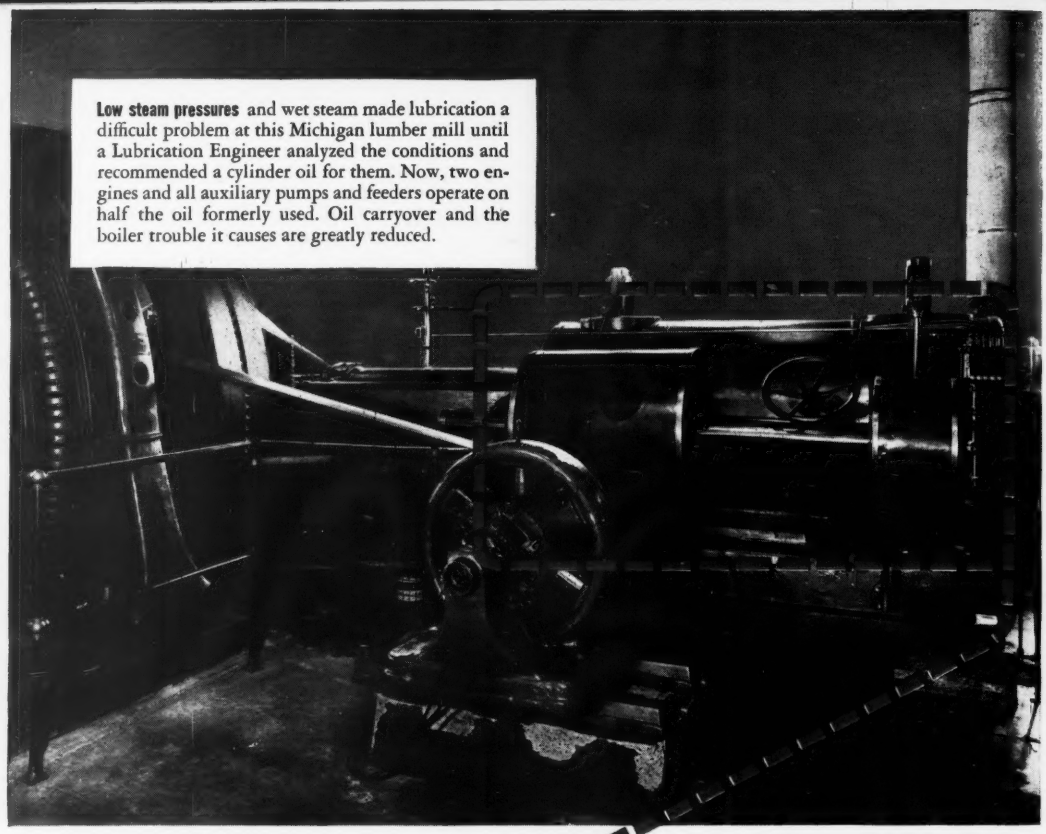
Dip bearing in a light lubricating oil. Allow excess to drain before repacking.

Put grease only in depression of spacer (both sides). Then spin one of the races, and wipe off excess grease thrown out. Replace the bearing. Do not put additional grease in the bearing housing.

STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE

•LUBRICATION ENGINEERING••LUBRICATION ENGINEERING••LUBRICATION ENGINEERING••LUBRICA

RICATION ENGINEERING...LUBRICATION ENGINEERING...LUBRICATION ENGINEERING...LUBRICATION EN



Low steam pressures and wet steam made lubrication a difficult problem at this Michigan lumber mill until a Lubrication Engineer analyzed the conditions and recommended a cylinder oil for them. Now, two engines and all auxiliary pumps and feeders operate on half the oil formerly used. Oil carryover and the boiler trouble it causes are greatly reduced.

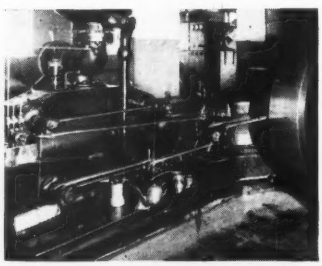
Assure needed power for war loads

THERE'S little stirring military action about the plants pictured here. But the extra power to produce the machines of war must come from plants just like these, and yours. That power must not fail for any reason—particularly not from improper care or lubrication, because it is so simple to make sure that lubrication is not the cause.

You can't make a better first step than to reexamine your whole problem of steam engine lubrication—your lubricants and lubricating methods. See where they might be affected by the new demands on equipment—the longer hours of operation, and heavier loads. Look at consumption records, for example. Increased consumption may indicate increased wear.

As a double check, let a Standard Lubrication Engineer work with you. He's helped many plants facing war power demands. He's had a chance to see where troubles strike first. He may have many helpful suggestions for you.

If you don't already know the Standard Oil Engineer in your locality, call the nearest Standard Oil (Indiana) office, or write 910 South Michigan Avenue, Chicago, Illinois, and ask to have a Lubrication Engineer stop at your plant.



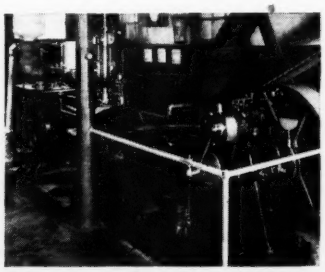
Since the last war when the 200 H. P. engine (above) was switched to a Standard steam cylinder oil, operation has been almost continuous, with little or no maintenance. The cylinder has never been rebored and rings have been replaced only once.

★ ★

STANDARD STEAM CYLINDER OILS

★ ★

Oil is Ammunition . . . Use it wisely



Millwork for defense housing is this plant's job. An analysis of steam pressures and loads, and a thorough check of feeds for adequate cylinder and valve lubrication led to a recommendation of Stanocyl Cylinder Oil. This has kept this engine free from all lubricating trouble.

STANDARD OIL COMPANY (INDIANA)

YOU CAN BANK ON FAIRBANKS

for REGRINDING Iron Globe, Angle and Cross Valves

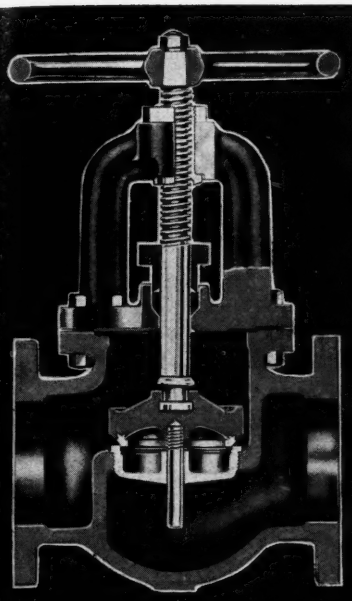


Fig. 0131

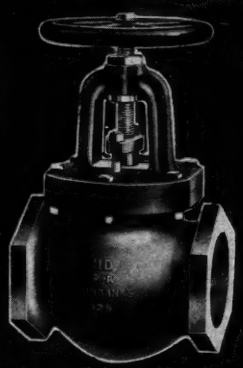


Fig. 0130

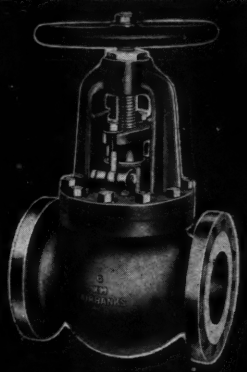


Fig. 0110

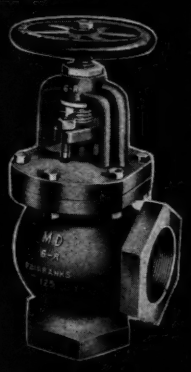
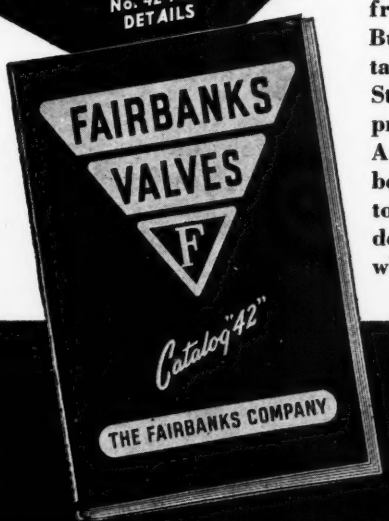


Fig. 0132

OTHER FAIRBANKS VALVES

Bronze Globe, Gate, Angle Cross and Check Valves
Iron Globe, Gate, Angle, Cross and Check Valves
Faircoseal Bronze Valves
U-Bolt Gate Valves
Asbestos Packed Cocks
Bronze Radiator Valves
Sphero Ball Valves

CONSULT FAIRBANKS NEW CATALOG No. 42 FOR DETAILS



SERVICE: Recommended for service on steam, water, oil and gas lines. Available for steam working pressures from 125 to 250 lbs.

TYPES: These Valves have Regrinding Bronze Bevel Discs and Seats and are recommended where close regulation of flow is required.

FEATURES: Disc and Seat may be reground without removing valve from pipe line. Seat Ring can be easily removed and replaced. Bodies and Bonnets are semi-steel, with an average tensile strength of 38,000 lbs. per sq. in. The globular-shaped bodies have maximum allowance for free-flow passages. Renewable Bronze Yoke Bushing provides a non-corrosive stem contact and reduces wear on threads. The Bronze Stems have Acme cut threads of generous proportions for strength and easy operation. A spider in seat ring and a guide stem on the bottom of discs, guide the bevel-faced discs to proper seating contact. Stuffing box is deep and can be repacked under pressure when wide open.

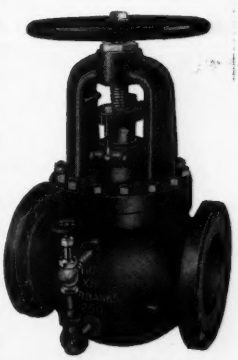
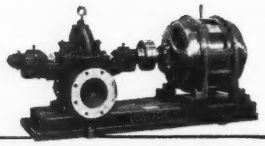


Fig. 0110
with By-Pass

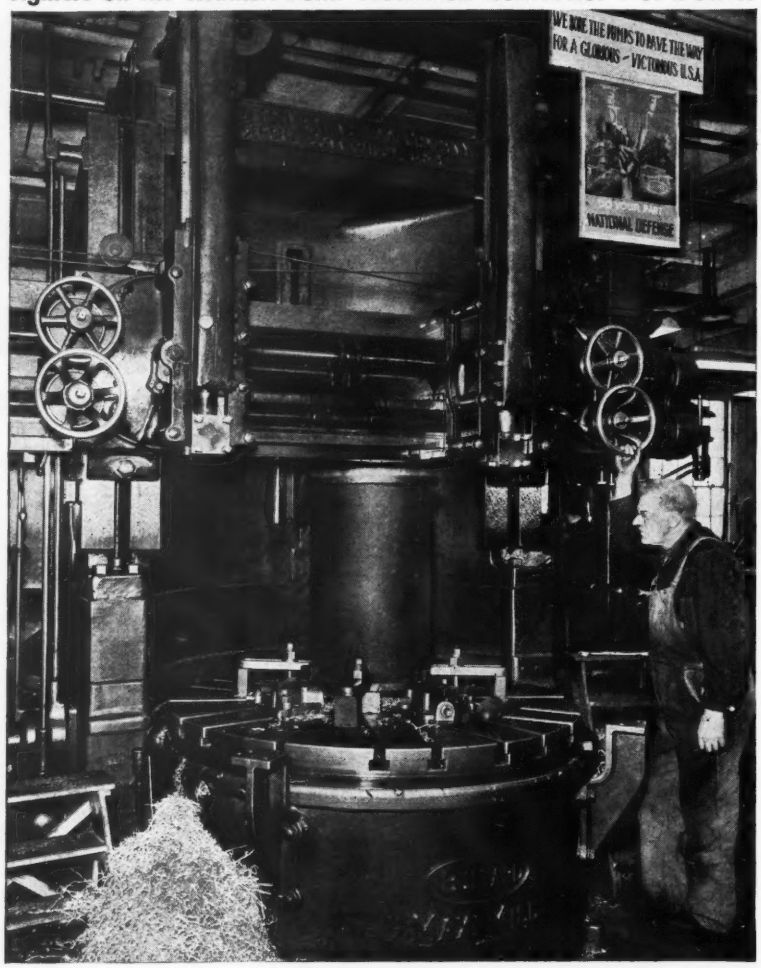
THE FAIRBANKS COMPANY

393 LAFAYETTE ST., NEW YORK, N. Y.
BOSTON, MASS. PITTSBURGH, PA.

Distributors in Principal Cities



Fighters on the WARREN PUMP Production Front.. No. 1 of a Series



"BIS" MANNED THIS "BATTLE STATION" ALL THROUGH THE LAST WAR, TOO . . .

"Bis Gould has been a skilled pump maker — at the Warren Steam Pump Co., Inc.— for 40 years. All during World War I, "Bis" operated the same vertical boring mill (shown above), which, today, he is now using to help turn out Warren Pumps needed to help bring the present world tyrants to their knees.

There is no compromise in the quality and skill of Warren workers . . . no compromise in the quality of Warren pumps. Whether Warren Pumps are used for gruelling 24-hour duty in war plants . . or for active duty with the United States Navy, the Coast Guard, or the Merchant Marine, every piece of Warren equipment can be counted on for efficient, reliable, and economical performance.

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC.
WARREN, MASSACHUSETTS

main anode transformer and all tubes requiring cooling are air-cooled by a ductless system.

The charging and discharge-tube circuits are mounted on a single, hinged compound base that can be swung out readily for servicing. The control station can be removed from the cabinet and attached to the welding machine. With this arrangement, the control cabinet can be at some remote point, thus conserving valuable factory space. Also, the small wiring between the various panels and the control station is brought to a centralized terminal board. Easy and rapid checking of the circuits is thereby made possible.

Rotary Hand Pump

A NEW rotary hand pump, designed primarily for use as a bilge pump on life boats has just been announced by the Blackmer Pump Co., Grand Rapids, Mich. However, tests indicate that there are a number of other applications, both marine and industrial, of this new unit.

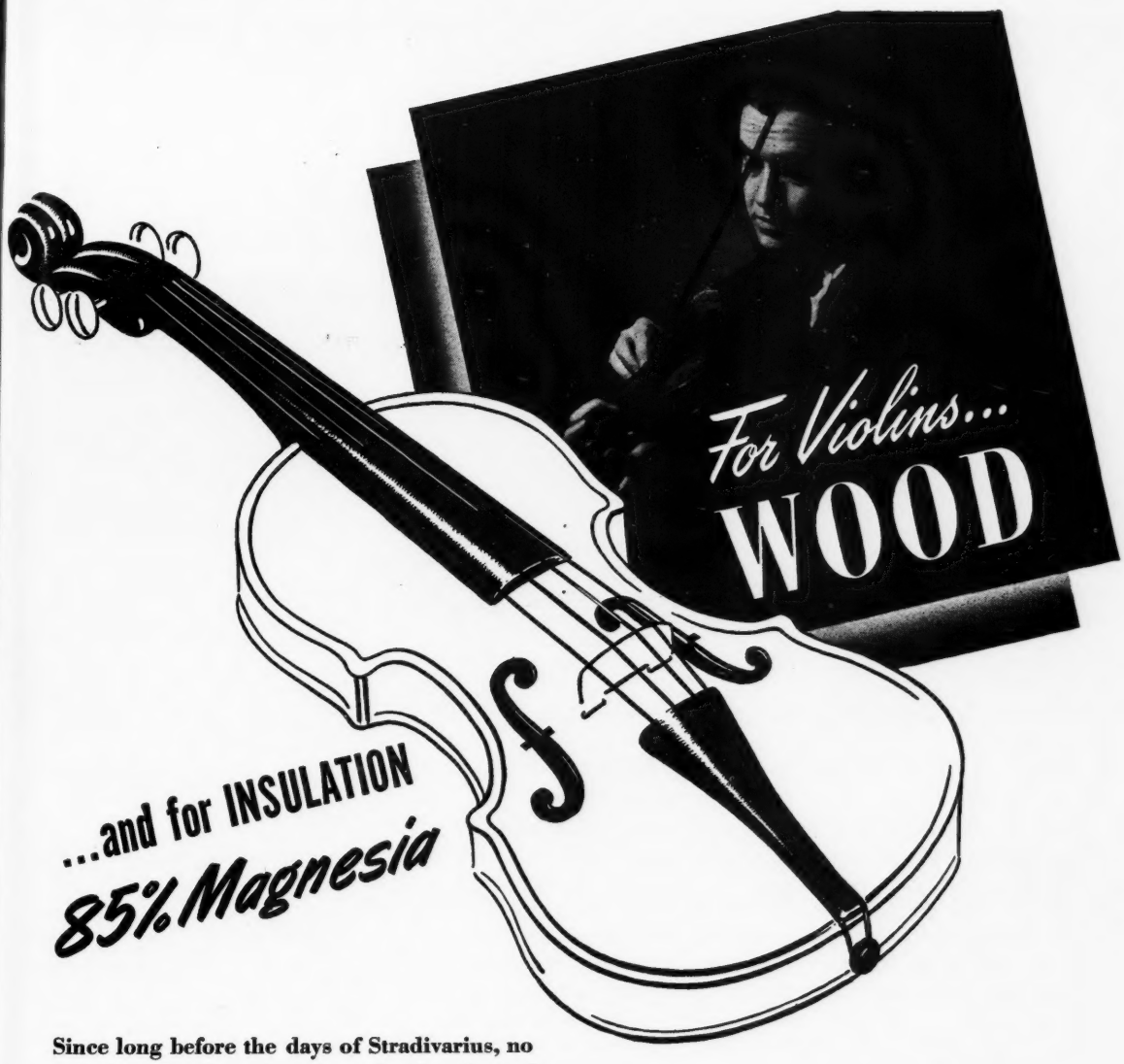
The base is fitted with an offset flange, which permits mounting on the edge of any flat surface, such as the top of a tank, vat or other container, while providing ample clearance for free operation of the crank. The casing, rotor and buckets of the new pump are made of bronze for life boat service. For other services they may be made of iron with bronze fittings, or all iron. The casing bolts on the life boat pumps are fitted with special wing-nuts for easy removal. For other services standard hex-nuts are used. Intake and dischage ports are 1 in. and threaded for standard pipe or hose connection.

Wearproofing for Patterns and Core Boxes

METAL spraying equipment for wearproofing wooden core boxes and foundry patterns against the abrasive action of sand is announced by the Alloy-Sprayer Co., 2040 Book Bldg., Detroit, Mich.

The worn surfaces are sprayed with a light coating of metal. This is said to prolong the life of the patterns, eliminates the necessity of frequent and costly rebuilding, and also permits worn wooden patterns of boxes to be completely renewed by the same means.

The equipment is designed to be foolproof and is said not to require special skill for operation, it is self contained and does not require extensive costly equipment to be used in conjunction with it.



Since long before the days of Stradivarius, no substitute has been found to take the place of wood in a violin. Time has proved it the *one* material for the purpose.

And in the field of industrial heat insulations, 85% Magnesia is the *one* material that has proved its ability to maintain efficiency . . . decade after decade. Records of more than half a century confirm this statement.

It will pay you to continue to specify and use Ehret's 85% Magnesia.

EHRET'S 85% MAGNESIA and many other Ehret heat insulating materials are fully treated, both as to selection and application, in the new 176-page Heat Insulation Handbook. It will be furnished, without obligation, to those interested in getting the most from their thermal insulations. Write today for your copy.

EHRET MAGNESIA MANUFACTURING CO.

Ehret

VALLEY FORGE, PENNA.

...THERE IS AN *EHRET* DISTRIBUTOR OR CONTRACTOR IN EVERY INDUSTRIAL AREA

Supervised Boiler and Condenser Cooling System Protection at Moderate Cost!

We believe the true answer to your boiler water and condenser cooling system problem lies in competent supervision of water conditions by experts plus a simplified natural method of water correction. Our new Technical System does just that! Scheduled supervision and treatment based on frequent water analysis finds and remedies your trouble . . . specific organic formulas developed individually to fit your needs provide a simplified, natural correction. Send the coupon below for the new Technical System bulletin or have a Water Treatment Company engineer inspect your plant without obligation.

WHY NOT SEND THIS COUPON *NOW?* . . . *to*

American Radiator & Standard Sanitary CORPORATION — New York — Pittsburgh

Cleveland, Ohio · Columbus, Ohio · Erie, Pa. · Fort Wayne, Ind. · Toledo, Ohio

BAILEY-FARRELL COMPANY
Charleston, W. Va. · Huntington, W. Va.

MUTUAL SUPPLY CO., Cincinnati, Ohio

or send to

☐ Please send the new Technical System bulletin.
☐ Have a Water Treatment Company engineer call.

Name ..... Title .....

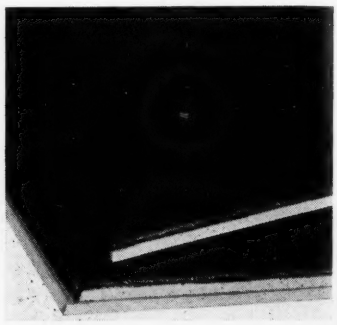
Company .....

Address .....

WATER TREATMENT COMPANY of America
1152 HODGKISS STREET · PITTSBURGH, PA.

Gypsum Construction Materials

NEW GYPSUM products developed to meet the immediate demands of wartime construction have recently been put on the market by The Celotex Corp., Chicago, Ill. The new products are intended to replace more critical materials, such as steel and lumber, in both temporary and permanent structures. WPB is advocating the use of such gypsum products in place of less available materials.

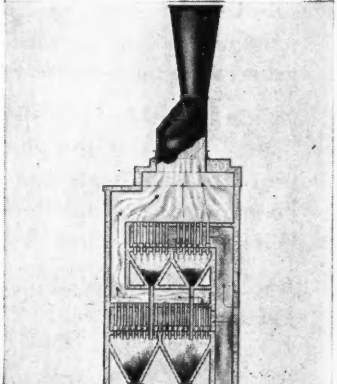


The products include a new gypsum exterior siding covered either with smooth or mineral surfaced roofing; laminated gypsum wall-board panels suitable for demountable or permanent single wall interior partitions; laminated gypsum roof deck slabs; and poured gypsum roof decks for use with wood frame industrial construction.

Ceramic Tubes in Dust Collectors

TUBES of special fire clay, manufactured by the Prat-Daniel Corp., Port Chester, N. Y., are being used in Thermix Ceramic Tubular Dust Collectors instead of the steel tubes previously used.

These tubes are reported to be sufficiently thick and rugged to be proof against fracture and breakage from normal handling or from changes in temperature, yet they weigh no more than the steel tubes previously used and are made of extremely hard and abrasive-

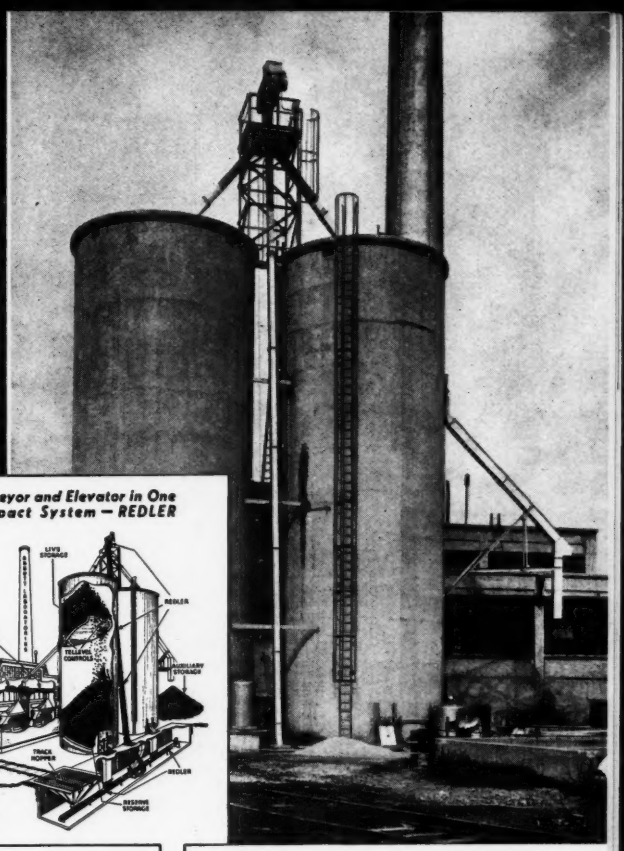


resisting special clay. They are mounted in a concrete or brick casing above concrete bins, entirely eliminating the use of steel.

The operating design of this dust collector is the same as the steel-tube Thermix Dust Collectors made by the same manufacturer.

What to Do...

—When War Restricts Liquid Fuel —Takes Away Men Needed to Handle Solid Fuel



CONVERT to COAL With

S-A Conveying-Elevating Equipment

When you consider the many advantages of coal, remember the handling job which once took so much manpower, can be done automatically. Stephens-Adamson Conveying and Elevating Equipment, designed and built today on the experience of over 40 years, accomplishes this in a variety of ways:

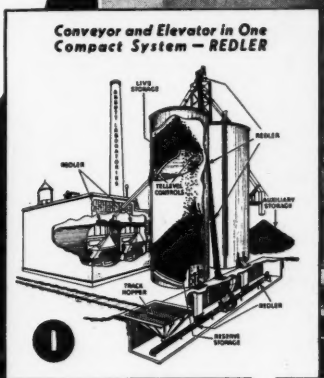
Compact, sealed Redler Conveyor-Elevators move coal in a continuous stream, with a minimum of power consumption and a maximum of efficiency. (Diagram and Illustration No. 1).

Pivoted Bucket Carriers elevate and convey large tonnages of both coal and ash. (Diagram 4).

Gravity Discharge Elevator-Conveyors are built for coal handling requirements of many other types of power plant installations. (Diagram 2).

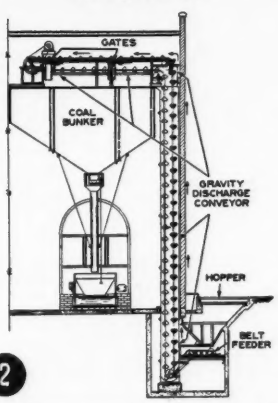
Bucket Elevators and Belt Conveyors, along with various types of Feeders and Crushers engineered and manufactured by S-A are serving power plant operators throughout the country. (Diagram 3).

Conveyor and Elevator in One Compact System — REDLER



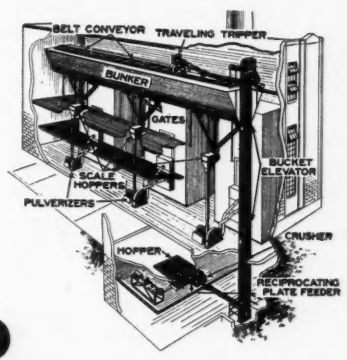
1

Standard Gravity Discharge Conveyor



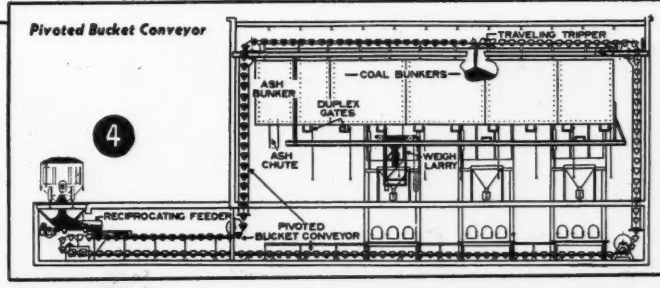
2

Belt Conveyor and Bucket Elevator



3

Pivoted Bucket Conveyor



4

Equipment can be furnished to meet your particular problem. Contact S-A Engineers for details on a coal handling installation which will save you time and money. Write for descriptive bulletins.

STEPHENS-ADAMSON MFG. CO.

Chains and Sprockets · Belt Conveyors · Bucket Elevators · Crushers
Bin Gates · Pan Conveyors · SealMaster Ball Bearings · Feeders · Screens
Speed Reducers · Redler Conveyors · Skip-Hoists · Winches and Car Pullers

5 Ridgeway Avenue, Aurora, Illinois

A 2½" layer of B-H No. 1 Cement which can be economically applied, minimizes heat-loss on this feed-water heater.

You'll be interested to tick off these reasons for trying B-H No. 1 Cement, to see whether you've been using something less desirable:

1. Mixes with cold water to form a plastic mass which can be readily troweled to the surface of the equipment to be insulated.

2. Trowels smoothly and sticks easily to brick or metal.

3. A special rust inhibitor prevents corrosion between the metal surface and the insulating cement, thus insuring a permanent bond of the insulation and no pitting of the metal surface.

4. Effective for temperatures up to 1800° F. If not used above 1200°, it can be broken up, remixed, and used again.

5. Practically no shrinkage, so that it does not crack or pull, and 100 lb. covers approximately 60 sq. ft., 1 inch thick.

6. Its base is B-H Black Rock-Wool which is fine, resilient, high-fusing, light-weight, and extremely permanent.

Try B-H No. 1 Cement on a tough little job like this. Check its ease of application, adherence, rust prevention, and high insulating efficiency.

Write today for a free 5-lb. sample. You'll enjoy playing with it on a patch job—and we'll prove our case.

BALDWIN-HILL *Insulations*

577 KLAGG AVE. TRENTON, N. J.

NEW YORK CHICAGO KALAMAZOO

Magnetic Base Portable Drill

PORTABLE drill with an electro-magnetic base developed to speed the job of drilling and tapping holes in larger water-wheel generator frames and similar equipment in manufacture at General Electric's Schenectady Works can also be used for counterboring and countersinking.

Holes in the generator frame, a 1¾-in. casting, are drilled and tapped at an angle, using the holes already drilled in ⅜ in. cover plates for templates. One man can set up and perform the operation easily.

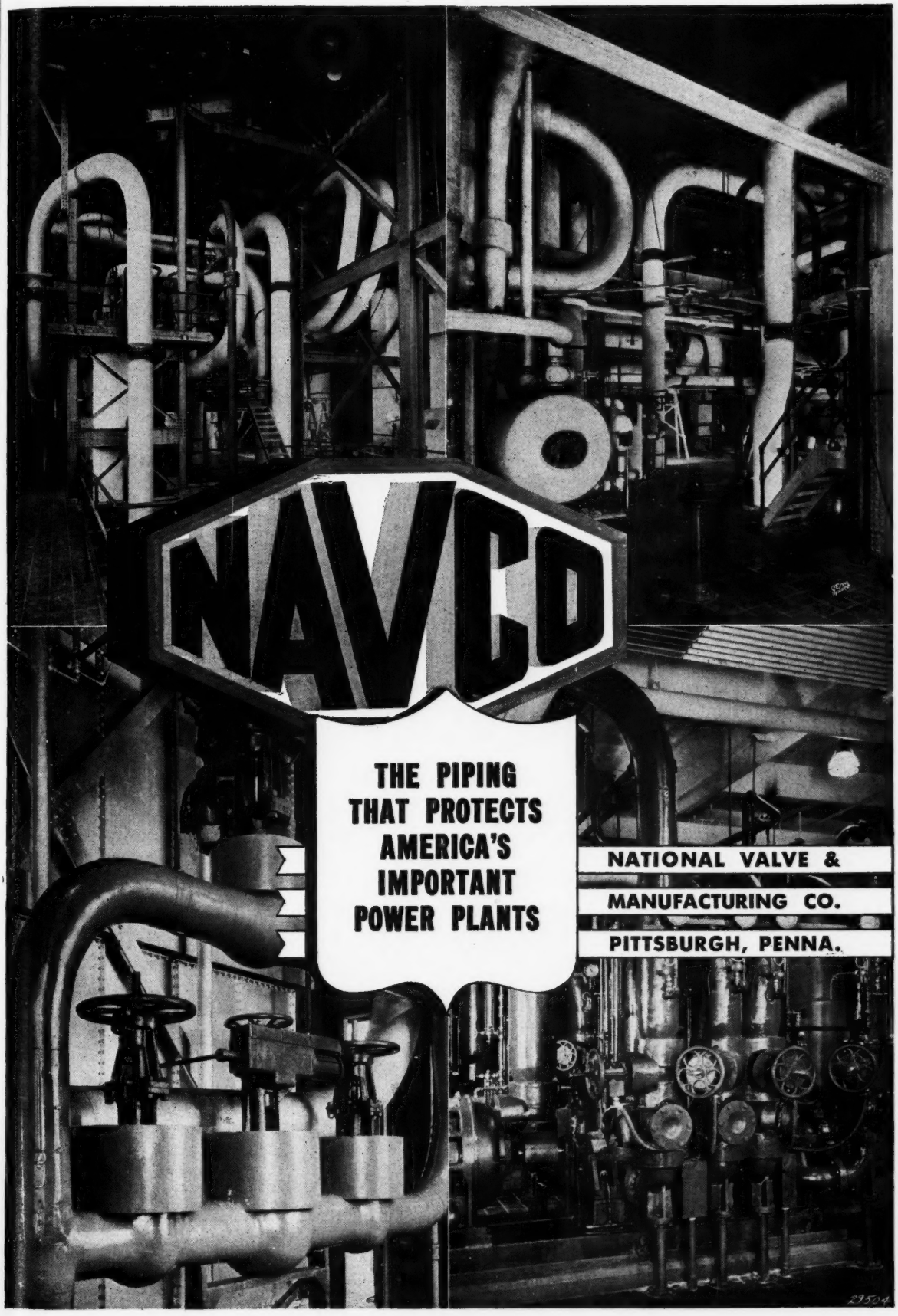
The tool consists of a railbonding drill frame altered to make a reversible multivane drill. A third leg added to the frame provides stability. The drill is fitted with a taper socket and a quick-change chuck to speed the changeover from drill to tap, since once the drill is positioned the hole is drilled and tapped without disturbing the setup. The drill is ratchet fed.

The electro-magnet used will exert a force of about 500 lb. on material with a minimum thickness of ⅜ in. and equal force on material of greater thicknesses. An air gap of 10 mils between the poles of the face plate and the cover plate compensates for irregularities on the cover plate surface. The magnet operates on 120 v. and is energized and de-energized by means of a toggle switch conveniently located on the frame. A foot-treadle is used to lower the magnet to the work and to raise it for repositioning the drill. When the magnet is in the raised position, the three-legged frame can be moved about easily on its ball casters. A solenoid-operated air valve between the air source and the drill keeps it inoperative unless the magnet is energized.

Anti-rust, Anti-corrosion Agent

A NEW type of anti-rust, anti-corrosion agent, Rustbuster No. 3, has been announced by Cannon Chemical Co., Inc., Everett, Mass.

In steam systems, it is claimed that this new chemical not only counteracts rust and its resulting corrosion in the boiler and boiler water, but also acts as a rustproofing agent throughout the entire system. It is designed to be applicable in air conditioning systems, in water lines such as spray water in spray chambers, condensate pipes connecting with cooling towers or evaporative condensers, and also chilled water lines.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AMERICA'S
IMPORTANT
POWER PLANTS
NATIONAL VALVE &
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PITTSBURGH, PENNA.

Speed Printer

A PRACTICAL speed printer, Spee-Dee, for making blueprints or black and white prints has recently been developed by Peck & Harvey, 4325 Addison St., Chicago.

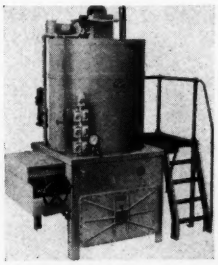
The printer is a sturdy, portable table model and can be plugged into any standard electric outlet. It is available in two sizes, for prints up to 12 by 18 in. and 18 by 24 in. The actual printing surface is oversize on both machines, which prevents crowding of prints, overlapping or blurred edges.

Tracings, drawings, letters, invoices or any written or printed matter can be duplicated on the printer.

Lubricating Oil Reclaimer

NEW MODEL oil reclaimer designed for aircraft engine builders—to be used in salvaging the vast quantities of high grade oil drained from the aircraft engines they build—is now being manufactured by the Youngstown Miller Co., Sandusky, O.

These new models, now in use by several aircraft engine builders, either are, or soon will be salvaging as much as 2500 gal. of lubricating oil per 24-hr. day. These plants also use the reclaimers to salvage hydraulic oils. Reclaimers in several smaller capacities are serving a number of Diesel engine builders to salvage used lubricating oil from the engines they build; and railroads for reclaiming oil drained from Diesel locomotives.



Diesel municipal power plants use the machine to keep the oil in their engines clean. Bus, truck, and motor fleet operators of all kinds and sizes are saving oil by reclaiming all the oil drained from their equipment. Another interesting application is the use of this equipment for salvaging transformer oils.

This purifier is of contact earth filtration type, utilizing common refinery earths available on the open market. It is designed to remove non-lubricating volatiles by slow heating; solids and asphaltic material by filtering; and is capable of removing fuel dilution, water, acids, solid and colloidal carbon, dirt and similar matter. Insofar as the contaminants are concerned, the oil can be restored for re-use in the same manner and place as the new parent oil. It is claimed that this method will reduce acidity to new oil values.

Variable Speed Mechanism and Gear Reducer

A NEW UNIT IN the line of variable speed control equipment built by Reeves Pulley Co., Columbus, Ind., is the Reeves Reducer-Type Transmission.

This drive, which consists of the standard Reeves Variable Speed Transmission with built-in Speed Reducer, has been developed to meet the many requirements for accurate speed control and speed reduction combined in one compact completely enclosed unit. An outstanding advantage of this Reeves drive is that far less mounting space is needed to obtain the lower

YOU CAN KEEP UP-KEEP DOWN
WITH WILSON TUBE CLEANERS
Today, more than ever before, it is essential that boilers—like all other mechanical equipment—are maintained at maximum efficiency. Shutdowns for tube cleaning reduce plant production and improperly cleaned tubes necessitate more frequent cleanings. So, whenever a boiler must be cleaned it is sound business to always use a tube cleaner which operates at maximum efficiency and which does a rapid and thorough cleaning job. This will reduce the number of cleanings per year, will keep up-keep down and will increase production.
Wilson Tube Cleaners clean straight or curved ferrous or non-ferrous tubes of large or small diameter faster, better and more economically because they have more speed, more power and more efficiency built into them.
Write for the name of our representative nearest to you, or ask for a copy of our NEW 40-page catalog which fully describes and illustrates the complete line of Wilson tube cleaning equipment.
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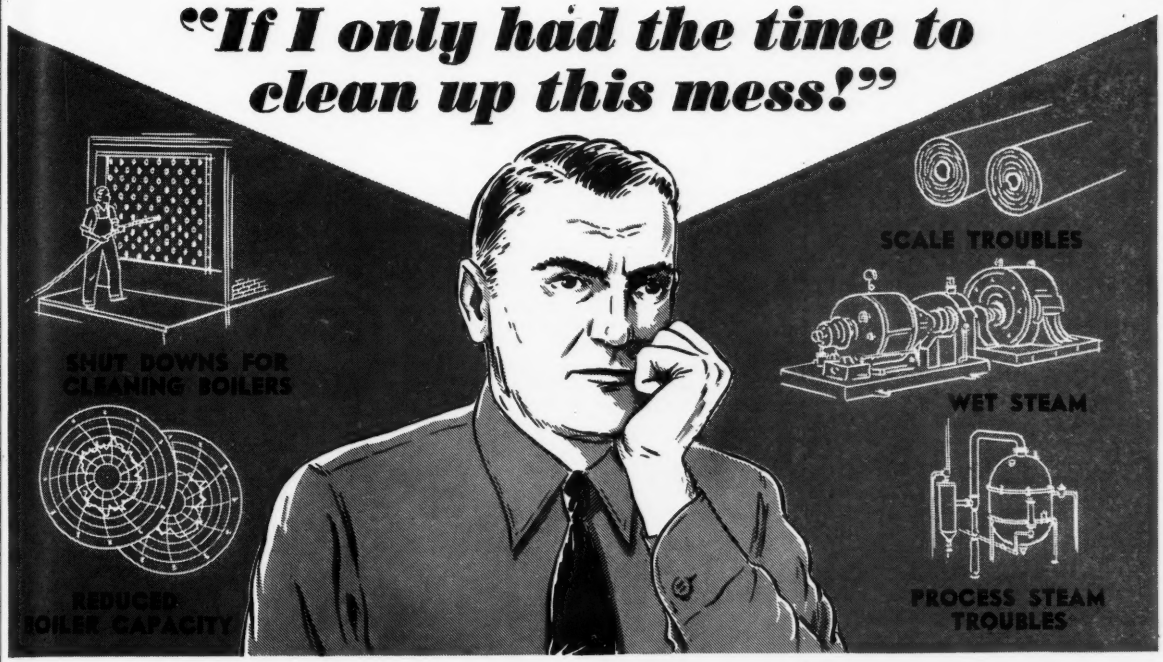

"If I only had the time to clean up this mess!"
SHUT DOWNS FOR CLEANING BOILERS
SCALE TROUBLES
WET STEAM
REDUCED BOILER CAPACITY
PROCESS STEAM TROUBLES

Mister, you don't need time: ELGIN can take over the whole job RIGHT NOW

FORCE boilers beyond a certain point and in most plants you run into scale troubles, carry-over, wet steam, dirty steam, shut-downs for cleaning, reduced boiler capacity. In other words, the very act of speeding up often causes a slowing down—the old story of "diminishing returns."

Worse still, the troubles encountered are superimposed on other problems attendant to today's peak production schedules. No wonder, then, that many an operating man is saying or thinking: "If I could only find time to clean up this mess!"

If that is your thought consider this: It isn't *time* you need; all you need is an organization capable of coming in and taking the whole problem off your hands and off your mind. Such an organization is Elgin—a fact borne out by results achieved in hundreds of plants like yours.

Elgin goes at it the way you would have it done: determines the best, the most expedient, the most economical way to lick your water conditioning problem, whatever its nature may be. Elgin can approach your problem this way because Elgin equipment and methods cover every phase of water conditioning and therefore Elgin recommendations are wholly unprejudiced.

Equipment built and installed by Elgin includes Zeolite Water Softeners,* Deconcentrators for removing sludge and suspended matter from boiler water, Continuous Blowdown Heat Exchangers, Water Filters and Purifiers. Elgin Water Treating Chemicals are individually prescribed after complete water analysis and engineering surveys. They include boiler water treatments, process water treatments, hot water treatments, general cold water treatments. Such treatments solve the problem of many plants, and are particularly important where mechanical equipment is restricted.

Our district engineer will be glad to explain Elgin methods in detail and arrange for water analysis and engineering survey—made without any charge or obligation whatsoever. Let us show you how we can take the water conditioning problems off your hands—and mind—*right now!* District engineers located in all principal cities.

** Our newest "Double-check" type Zeolite Water Softener gives up to 44% more capacity—prevents zeolite loss.*

ELGIN SOFTENER CORPORATION
136 NORTH GROVE AVENUE
ELGIN, ILLINOIS

ELGIN
Water Conditioning for every need

range of speeds which formerly required the use of auxiliary speed reducing equipment.

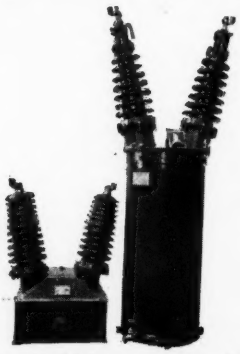
The Reeves Reducer-Type Transmission is available in two enclosed designs—horizontal and vertical, which may be mounted in any convenient or desired position. Each design is available in a wide range of speeds and in capacities from 1 to 7½ hp. inclusive. The Transmission in various sizes produces ratios of speed variation from 2:1 through 12:1 and the reduction gears provide ratios up to and including 6.9:1. Speed changes are effected by turning a handwheel or, if completely automatic regulation is desired, it is available by mechanical or hydraulic methods.

Small Outdoor Potential Transformers

GENERAL ELECTRIC announces a new line of two-bushing outdoor potential transformers, Type E-236, rated 24 to 69 kv., 50/60 cycles, which effect substantial reductions in size. The height of the new transformers (which supersede the Type E-116) has been reduced 15 to 50 per cent, weight has been reduced 10 to 60 per cent, and liquid volume, 45 to 90 per cent, depending on the rating of the transformer.

These reductions mean that the transformers can be mounted up in the substation structure with the small-size G-E current and single-bushing transformers. Mounting in the structure simplifies primary (high-voltage) connections, saves valuable ground space, and eliminates the need for constructing a separate foundation.

The new transformers have no gaskets. They are hermetically sealed by means of sealed bushings, all-welded steel tank, and sealed-in-glass secondary terminals. The transformers, which can be supplied filled with either Pyranol or

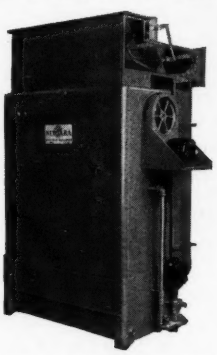


oil, meet the highest accuracy classifications, ¼ W, ¼ X, ¼ Y, and ¼ Z. Ample insulation is provided to meet the ASA standards for impulse and low-frequency tests.

Temperature Control for Heat Exchanger

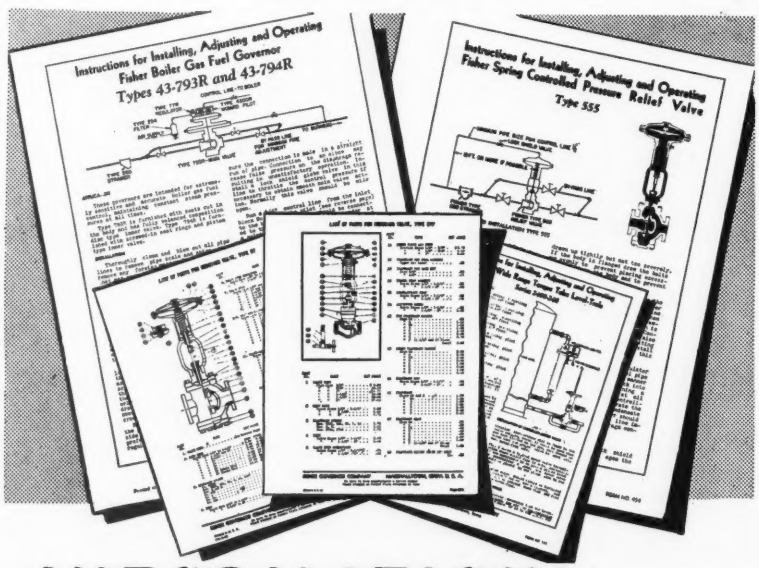
NEW METHOD of automatic temperature control for the Niagara Aero Heat Exchanger as used for cooling industrial liquids is announced by the Niagara Blower Co., New York, N. Y.

This method is based on controlling the amount of outside air passed through the evaporative cooling chamber rather than altering the flow of liquid being cooled. Accuracy is improved, it is claimed, with the cooling effect directly proportioned to load changes, giving a modulated, nearly straight-line temperature control with



no hunting action. Water savings are increased, it is stated, and when the heat exchanger is used to cool oils or compounds, there is no settling of solids, restricted flow or clogging of tubes to interrupt operations.

The apparatus comprises a recirculating air duct to which outside air is admitted by dampers controlled by a thermostat in the liquid line where it is always in contact with the full flow of the liquid being cooled. Only the minimum amount of outside air is admitted, keeping spray water temperature above freezing to prevent damage to equipment in cold weather.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INFORMATION for Operating Engineers

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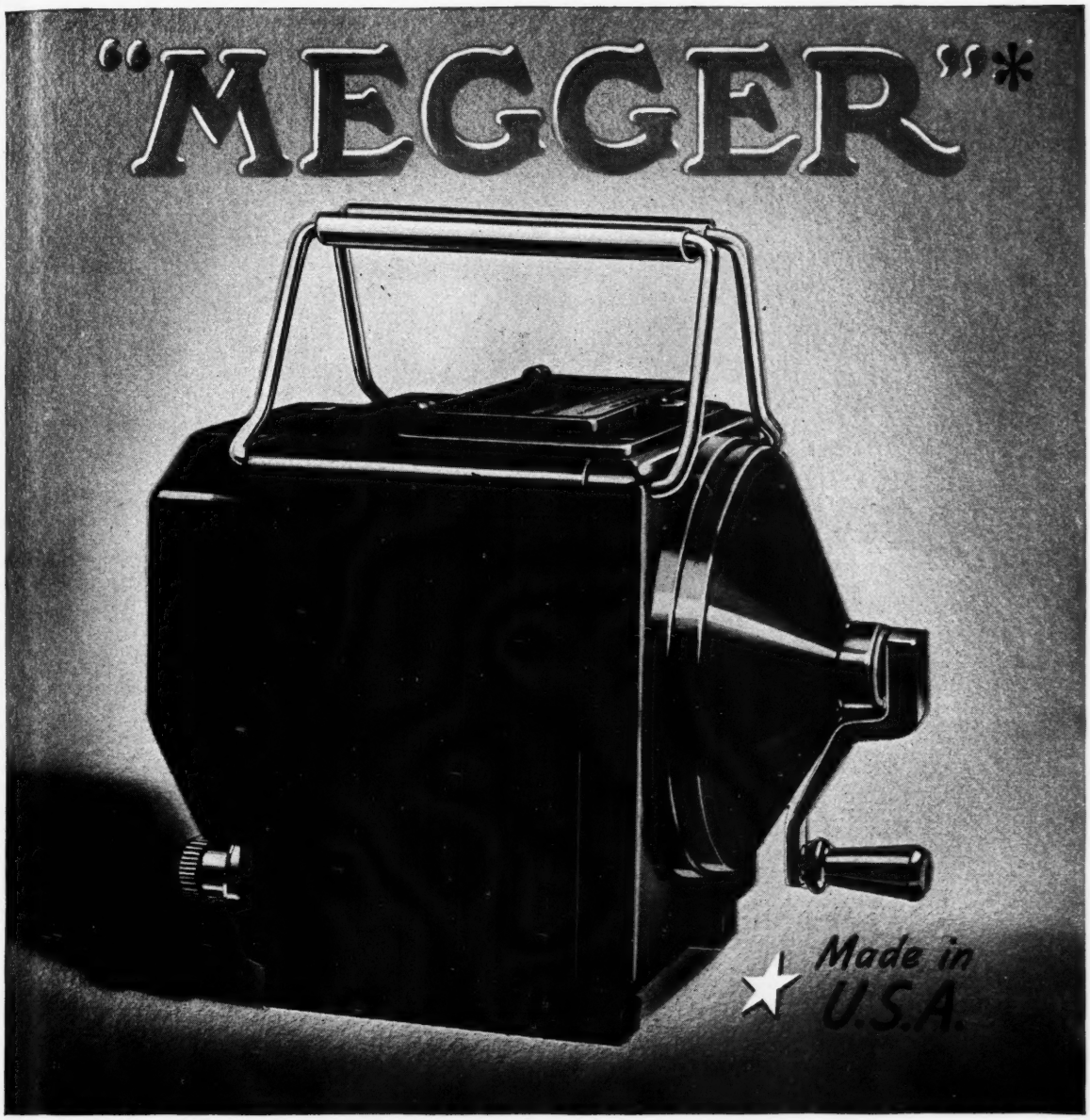

THE *NEW* "MEGGER" INSULATION TESTER...

The first U.S.-made "Megger" Instruments for testing electrical insulation resistance are now being built in our Philadelphia factory and we expect to be in full production by about June 1st of this year.

These new "Megger" testers are of the same hand generator and direct reading ohmmeter type, and the same high quality, as our time-tested "Meg" and "Super-Meg" instruments, which are so well-known for their great ruggedness and durability. They are housed in molded cases of high impact-strength plastic material.

Our manufacturing facilities are complete, and we now offer these new U.S.-made "Megger" testers for delivery as soon as your priority and our expanding production will permit. We invite your orders for them. *Write for new Bulletin Number 1735-PE.*

*By special arrangement with the original makers of the "Megger" Testing Sets, our new instrument carries the U. S. registered trade mark name "MEGGER."

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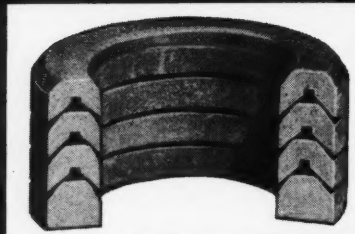

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Midwest Power Conference Program

April 8-9, 1943
Palmer House, Chicago

THURSDAY, April 8, 1943

9:00 a.m. Registration, Palmer House.

10:15 a.m. Opening Meeting.
H. O. Croft, chairman.

(a) Address of Welcome. H. B. Gear, vice-president. Commonwealth Edison Co., Chicago.

(b) Response for the Cooperating Institutions. M. P. Cleghorn, professor of Mechanical Engineering. Iowa State College.

(c) Electric Power Supply. C. W. Kellogg, president. Edison Electric Institute, New York.

(d) Practical Education in War Time. Philip W. Swain, editor of Power, New York.

12:15 p.m. Joint Luncheon with A.S.M.E.
J. R. Michel, chairman.

Speaker: E. H. van Delden. Industrial Relations Dept., Allis-Chalmers Mfg. Co., Milwaukee. "Company Organization of Manpower."

2:00 p.m. Power Plant Practice.
R. K. Behr, chairman.

Turbine Blade Deposits. Frederick G. Straub, Research Professor of Chemical Engineering, University of Illinois.

Conversion from Oil to Coal-Fired Steam Generating Units. Samuel I. Rottmayer, Mechanical Engineer, Chicago.

3:45 p.m. Electrical Distribution Session No. 1.
J. E. Hobson, chairman.

(a) Application of Shunt Capacitors to Meet Emergency War Conditions. Chas. F. Wagner, manager. Central Station Engineering, Westinghouse Elec. & Mfg. Co., East Pittsburgh.

(b) Application of Ground Fault Neutralizers. W. A. Lewis, director, School of Electrical Engineering, Cornell University.

(c) Design of Direct-Current and Low-Frequency Bus Systems; A Review of the Literature. Thomas J. Higgins, associate professor of Electrical Engineering, Illinois Institute of Technology.

3:45 p.m. Industrial Power Plants.
H. L. Solberg, chairman.

(a) Use of Automatic Control to Increase Plant Capacity. H. H. Gorrie, design engineer. Bailey Meter Co., Cleveland.

(b) Guideposts on the High Pressure Road. D. B. Jones, Engineering Service, Hall Laboratories, Inc., Pittsburgh.

(c) Engineering Aspects of Product Design Resulting in Power Saving. Ronald B. Smith. Director of Engineering Research & Development. Elliott Co., Jeannette.

6:45 p.m. "All Engineers" Dinner.
Informal. Red Lacquer Room. (Ladies Invited)

Toastmaster: James D. Cunningham, president. Republic Flow Meters Co., Chicago.

Speaker: Colonel James L. Walsh, chairman, War Production Committee, The American Society of Mechanical Engineers, New York. "Logistics, the Science of Survival."

FRIDAY, April 9, 1943

9:00 a.m. Plant Protection.
John I. Yellott, chairman.

(a) Accident Prevention in Public

SWARMS of American-built bombers smash deep into enemy territory, night after night...while the miracle of U. S. production, rapidly transforming America into the world's mightiest air power, approaches this year's new goal of 10-thousand planes per month!

Behind our vast and growing strength in the air . . . underlying our matchless achievements on the assembly line at home . . . is *America's mastery of power,* basic tool of all modern industry.

In plane-plants . . . in factories of every type from coast to coast...wherever the job calls for round-the-clock production . . . Todd Combustion Equipment is contributing uninterrupted power...assuring efficient and trouble-free firing of liquid and gaseous fuels. Over 50-thousand Todd units are now in action throughout America.

With technical service staffs stationed in key cities ...with parts and replacements instantly available... Todd Combustion Equipment is helping American industry to keep pace with the needs of our fighting forces overseas.

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NEW YORK MOBILE NEW ORLEANS GALVESTON SEATTLE BUENOS AIRES LONDON

MORE POWER for Tube Cleaning means MORE POWER for production

Roto Tube Cleaners can help you maintain maximum performance and efficiency of your tubular equipment with minimum expenditure of time and labor.

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Because you need to keep your plant in operation at top efficiency with a minimum of down time now, when maintenance crews are undermanned, it will be to your advantage to put Roto Tube Cleaners to work in your plant without delay.

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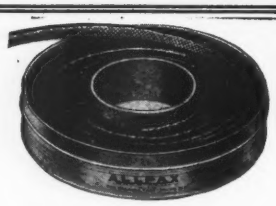

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Try it and you'll always use it. Full details on request.

Utilities. Major Ralph W. Applegate, C. E. chief, Industrial Safety Branch, Sixth Service Command.

(b) War Time Protection of the Power Plant. Lt. Colonel A. G. Coulson, O.D., chief, Continuous Security Branch, Sixth Service Command.

10:30 a.m. Plant Maintenance.
R. W. Jones, chairman.

(a) Breaking Bottlenecks in Piping Materials. G. W. Hauck, manager, Engineering Sales, Crane Co., Chicago.

(b) Boiler Maintenance Under War-Time Conditions. A. C. Foster, manager, Service Department, Foster Wheeler Corp., New York.

12:15 p.m. Joint Luncheon with A.I.E.E.
J. C. Woods, chairman.

Speaker: F. H. Hollister, chief engineer, Sargent and Lundy, Chicago. "Conservation in Design of Power Stations."

2:00 p.m. Electrical Distribution Session No. 2.
F. D. Troxel, chairman.

(Sponsored and arranged by the Power Group, Chicago Section, A.I.E.E.)

Subject: War-Time Industrial Power Applications of Electrical Equipment.

Speaker: D. L. Beeman, Industrial Dept., General Electric Co., Schenectady.

Discussion Leader: J. J. Orr, chairman, Committee on Industrial Power Applications, A.I.E.E., New York.

2:00 p.m. Diesel Power.
Hugh E. Keeler, chairman.

(a) Heavy-Duty Stationary Diesels. B. V. E. Nordberg, executive engineer, Nordberg Mfg. Co., Milwaukee.

(b) Effect of Fuel Composition on Deposition in Diesel Engines. L. E. Hebl, head, Engine Laboratory and L. W. Griffith, senior research engineer. Shell Oil Co., Wood River, Ill.

3:45 p.m. Fuels and Combustion.
R. E. Summers, chairman.

(a) Effect of Coal Sizing on Efficiency and Operation of Mechanical Stokers. Otto de Lorenzi, assistant general sales manager. Combustion Engineering Co., New York.

(b) Possibilities and Limitations of Small Hand-Fired Furnaces. J. R. Fellows, assistant professor of Mechanical Engineering, University of Illinois.

SPECIAL EVENING PROGRAM
RED LACQUER ROOM

7:30 p.m. Army Engineering Hour.
Alex D. Bailey, chairman.

(a) Repairs and Utilities Activities at Army Cantonments. Col. G. F. Lewis, chief, Repairs and Utilities Branch, Construction Div., Office, Chief of Engineers, U. S. Army.

(b) The Fuel and Heating Program at Army Cantonments. Lt. Col. Louis C. McCabe, chief, Heating and Refrigeration Section, Repairs and Utilities Branch, Construction Div., Office, Chief of Engineers, U. S. Army.

(c) Power and Lighting Problems at Army Cantonments. J. A. Heffernan, Electrical Facilities Unit, Maintenance and Utilities Section, Repairs and Utilities Branch, Construction Div., Office, Chief of Engineers, U.S. Army.

9:30 p.m. Social hour.
Headquarters: Palmer House, Chicago, Ill.

Conference Director: Stanton E. Winston, Illinois Institute of Technology.

Single stage, double suction pump with motor drive
Motor-mounted pump
Six stage centrifugal pump driven by electric motor
Section of De Laval-IMO oil pump
Steam turbine driven boiler feed pump
Clogless pump
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Centrifugal pumps driven by geared turbine for large water works plant

State requirements so that appropriate catalog may be sent.

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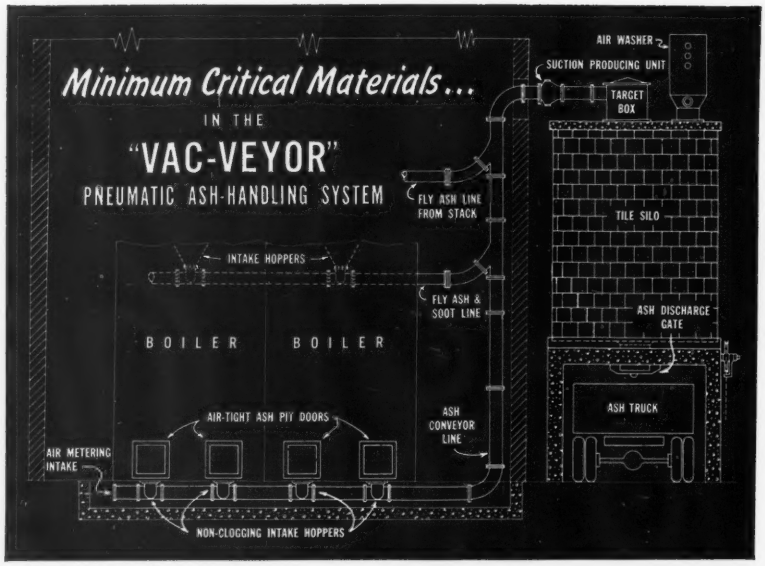

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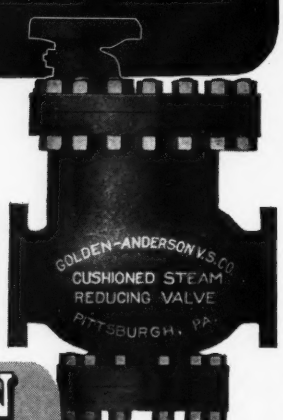
NOTE THESE 4 SERVICE ADVANTAGES

The Golden-Anderson Steam Pressure Reducing Valve will positively hold any adjusted delivery pressure "right on the nose" at all times. Particularly adapted for intermittent or dead end service. Pilot control may be located remotely from main valve. Efficiently handles 125 lb. to 400 lb. saturated or superheated steam. Write for free catalog describing complete G-A line.



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OBITUARIES

Max W. Babb

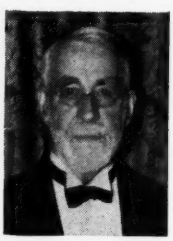
MAX W. BABB, chairman of the board of the Allis-Chalmers Mfg. Company, died March 13 in Milwaukee after an illness of several weeks. Mr. Babb, who had been board chairman since January, 1942 and the company's president for the 10 yr. prior to that, was 68 yr. old.

He joined the Allis-Chalmers organization in 1904 as the company's attorney. He had practiced law in Iowa with his farther after receiving his law degree from the University of Michigan in 1897. He obtained his bachelor of arts degree at Iowa Wesleyan in Mt. Pleasant, where he was born in 1874.

In 1913 Mr. Babb was made vice-president and general attorney of Allis-Chalmers, and was closely associated with the late General Otto H. Falk in the management of the concern which underwent tremendous expansion during and after the World War. He succeeded Gen. Falk as president in 1932 when Falk became chairman of the board.

Active in the Milwaukee Association of Commerce, he was the counselor representing that group in the United States Chamber of Commerce, and was also a member of the American committee of the International Chamber of Commerce. He was a trustee of Milwaukee-Downer College.

Charles T. Main

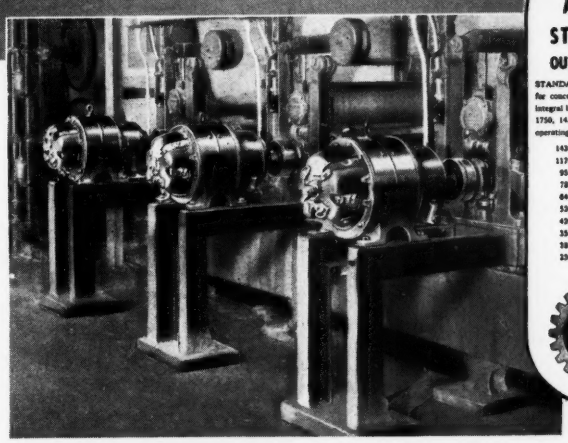


CHARLES T. MAIN, head of the firm of consulting engineers bearing his name, died on March 6, 1943, at his home in Winchester, Mass. He was 87 yr. old.

Mr. Main was born in Marblehead, Mass. He was graduated from M.I.T. in 1876 and began his engineering career as a draftsman in the Manchester Mills, later became superintendent of the Pacific Mills, Lawrence, Mass., and in 1893 began private practice as a partner in the firm of Dean & Main, consulting engineers of Boston, Mass. In 1907 this association ended and Mr. Main continued work under his own name until 1926 when the present firm of Charles T. Main, Inc., was formed.

During his career, Mr. Main and his associates designed and supervised the construction of many industrial steam-power and water-power plants. During World War I, Mr. Main was consulting engineer for the construction division of the U. S. Army. He went to France later as a member of the American engineering delegation selected to assist the French in rehabilitation work. In the present World

for *LINE DRIVES* or *DIRECT CONNECTED DRIVES* make your choice Philadelphia MOTOREDUCER



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A.G.M.A. STANDARD OUTPUT SPEEDS

STANDARD OUTPUT SPEEDS for concentric and parallel shaft integral hp Gearmotors. Based on 1750, 1430 or 1165 rpm motor operating speeds.

1430	190	25
1170	155	20
950	125	16.5
780	100	13.5
640	84	11.0
530	68	9.0
420	56	7.5
350	45	6.0
280	37	5.0
230	30	4.0

AGMA

The compact design of the Philadelphia MotoReduceR with its motor and speed reducer in a single housing greatly simplifies installation, and makes it an ideal choice for service where other types of drives are impractical. Furthermore, its rugged construction assures dependable, trouble-free performance with little attention. This has been proven by the countless units in service in all kinds of industrial plants during the past decade. Philadelphia MotoReduceRs are made in both horizontal and vertical types, in a wide range of horsepowers and ratios, with practically any available motor construction. Get our catalog MR 40 for details.

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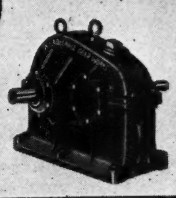
INDUSTRIAL GEARS AND SPEED REDUCERS LIMITORQUE VALVE CONTROLS

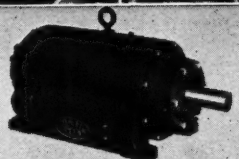
ERIE AVENUE & G STREET PHILADELPHIA, PA.
New York, Pittsburgh, Chicago

***Philadelphia* LIMITORQUE CONTROL** operates all types of valves, etc., safely, economically, from convenient stations.

***Philadelphia* GEARS** All types and sizes of industrial gears. Can be supplied in all materials.



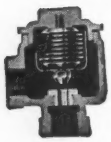
***Philadelphia* HERRINGBONE SPEED REDUCER** for heavy loads at high speed. Single, Double, Triple Reductions, various ratios and horsepowers.

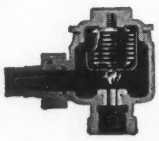


***Philadelphia* MOTOREDUCER** The economical self-contained drive, Horizontal or Vertical types — various ratios and horsepowers.

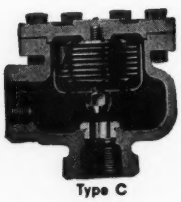
***Philadelphia* WORM GEAR SPEED REDUCER** right angle drives — vertical or horizontal. Wide range of ratios and horsepowers.

DON'T OVERLOOK THIS POSSIBILITY FOR INCREASED PRODUCTION


Type A


Type AU

Type B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Two to six times greater discharge capacity. Quick automatic action. No air-binding . . . no dribbling . . . no freeze-ups . . . no water logging . . . no adjustment. Frequent intermittent discharge induces rapid heat transfer in water heaters, pipe coils, kettles, driers, unit heaters, etc. Four types; sizes ¼" to 2"; pressures to 300 lbs.

BULLETIN No. 242—W. H. NICHOLSON & CO., 160 OREGON ST., WILKES-BARRE, PA.

NICHOLSON *Traps*

THERMOSTATIC ▼ PISTON AND WEIGHT-OPERATED STEAM GASOLINE AND COMPRESSED AIR TRAPS

CONTROL VALVES ▼ FLOATS ▼ MANDRELS ▼ STEAM AND AIR SEPARATORS

Win Today's Battle Against

with

ECLIPSE METAL HOSE

Its deep, parallel sidewall corrugations combine maximum flexibility with lasting toughness—makes Eclipse Seamless Metal Hose the logical low-cost material for Diesel exhausts and for handling all kinds of liquids or gases where vibration and expansion are present.

Eclipse Metal Hose withstands high pressure and temperatures. Monel hose is stocked in sizes ⅜ in. to 2 in. I.D.; steel hose can be produced up to 40 in. I.D. Write us about your problems of conveying non-solids, non-abrasives. Ask for descriptive bulletin.

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Precision Equipment by **Bendix**
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For

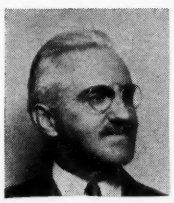
LOW COST LEAKPROOF HANDLING OF

OILS • CHEMICALS • REFRIGERANTS • GASES • AIR • STEAM • VACUUM • HYDRAULIC • Etc.

War, Chas. T. Main, Inc., is again engaged in some very important design and construction work in the war program.

Mr. Main received many engineering honors during his career. In 1935 he was awarded the annual medal of the A.S.M.E. for distinguished achievements and for eminent services to the engineering profession. He was a past president of the A.S.M.E., and also of the American Institute of Consulting Engineers and the Boston Society of Civil Engineers. He held the honorary degree of Doctor of Engineering from Northeastern University.

William F. Madill

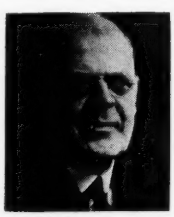


WILLIAM F. MADILL, vice president and one of the founders of Everlasting Valve Co., died at his residence in Nutley, N. J., on Saturday, January 9, 1943.

Mr. Madill was born in Canada in 1878. After completing his education in Canada, he went to Chicago, where he became associated with Scully Steel and Iron Co. Here, he was successively private secretary to the president, then president of a subsidiary company, and later manager of one of the branches of the company.

In 1908, Mr. Madill joined John H. Allen and formed the Everlasting Valve Co. to develop and market the Everlasting valve. This was at that time a radically new design of quick-operating, drop-tight valve. Mr. Madill became vice president of the company and continued in that position until his death.

John G. Barry



JOHN G. BARRY, honorary vice-president of the General Electric Co., died at his home in Schenectady, March 4, after a long illness. He was 75 yr. old.

Mr. Barry had retired as senior vice-president of the company in 1935 after more than 45 yr. service. His entry into the electrical industry was as an apprentice and test man with the Thomson-Houston Co., a predecessor of General Electric, in 1885 at Lynn, Mass.

Completing his apprentice training in 1890, he was assigned to the construction department of Thomson-Houston, later going to the company's Boston office.

In 1892, when the General Electric Co. was formed, he became a member of the railway department, which at that time was one of the company's two main divisions. From Boston he went to New York, and then to Schenectady, where in 1897, 3 yr. after his arrival, he was made assistant manager of the railway department.

Mr. Barry's understanding of the difficulties in his chosen field and his ability to solve them led to his appointment in 1907 as manager of the railway department. Widely known among

STEEL TUBES THAT MEET THE EXTRA *Demands* OF WARTIME SERVICE

THE *extra* margin of safety and strength so vital to modern high-temperature, high-pressure service is adequately provided in Globe Boiler and Pressure Tubes. Under the severe conditions of wartime service, Globe Tubes are proving the value of extra precautions taken in their manufacture.

In war production industries, power plants...in fighting, transport and merchant ships...in locomotives and other power units... Globe Boiler and Pressure Tubes are meeting extra demands of service.

Globe mechanical tubing serves many critical needs in aircraft construction. Globe engineers can help you to select tubes with the exact characteristics you require—feel free to consult them. Their service is yours for the asking.

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★ BOILER TUBES
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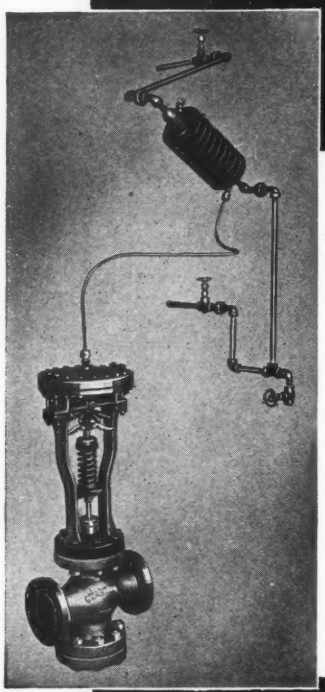
GLOBE STEEL *Tubes*

GLOBE STEEL TUBES CO., *Milwaukee, Wisconsin, U.S.A.*

Swartwout Feed Water Regulators

give break-down-proof service in thousands of plants like yours



DRIVING your plant to the utmost as you probably are, you can't overlook the tremendous importance of positive, consistent feed water regulation. • The Swartwout "S-C" System has a sound record of trouble-free performance—assuring sensitive quick-acting control that protects your boilers from dangerous water stages. Used on boilers from lowest pressure jobs to 2000 pound pressure central stations, its low maintenance has surprised and pleased thousands of engineers. • Simple, dependable, ruggedly built. Easily installed on any boiler—easily adjusted to varying requirements.

Write for Bulletin S-20-D.

THE SWARTWOUT COMPANY
18511 Euclid Ave., Cleveland, Ohio

Swartwout

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SCALE DEPOSIT IN 12-INCH STEAM LINE

This scale deposit was in a 12-inch steam header 400 feet from the boilers. Consider the enormous cost to this plant in lowered efficiency. Various water treatments were tried without results. Finally D. W. Haering engineers were called in for consultation. Haering Glucosates not only remove this scale and prevent further deposition but protect the steam line from corrosion.

D. W. HAERING & CO., Inc.
GENERAL OFFICES:
205 West Wacker Drive
CHICAGO, ILLINOIS

SEND FOR INFORMATION

D. W. Haering & Co., Inc.
205 Wacker Drive, Chicago

Please send information on Steam Treatment. (P.P.)

Name .....

City..... State.....

railway executives and public utility officials, he became a conspicuous figure in the development of the American street railway business, and for many years was a member of the executive committee of the American Electric Railway Assn. His notable success in developing the department resulted in his appointment as general sales manager in 1917, while still retaining the managership of the railway department. In June, 1922, he received the further distinction of being advanced to a vice-presidency. At this time, in association with Jesse R. Lovejoy, he had supervision of general sales in the apparatus field, and was succeeded as manager of the railway department by E. P. Waller.

In July, 1928, Mr. Lovejoy was appointed an honorary vice-president and retired from active duty, leaving Mr. Barry sole executive head of apparatus sales efforts.

Mr. Barry had made his home in Schenectady for more than 40 yr. and had played an active role in civic affairs, serving as a member of the Board of Education and as Fuel Administrator for the district during World War I. He was a director of the Schenectady Savings Bank, the Schenectady Trust Co., and a veteran member of the Chamber of Commerce. He was a member of the Engineers, Railroad, Bankers, and Lotus Clubs in New York, and of the American Institute of Electrical Engineers.

Arthur C. Flory

ARTHUR C. FLORY, 60, well known steam turbine engineer, died March 1 at his home in Milwaukee, after a long illness. For 24 yr. he had been manager of the Allis-Chalmers Mfg. Co.'s steam turbine department.

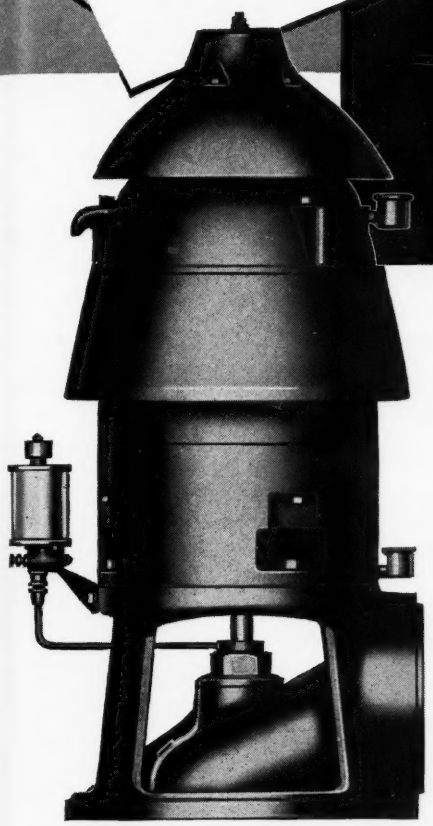
Mr. Flory was born in Scranton, Pa., and received his preliminary education in the public schools there and additional preparatory work at the School of Lackawanna in Scranton. Before continuing his education at Lehigh University and for periods between his studies there he also worked for industrial firms in Scranton and Elizabeth, N. J.

Upon the completion of his education as a mechanical engineer at Lehigh in 1905, he came to Allis-Chalmers. After rising to the position of assistant manager of the steam turbine department, he become manager in 1919. As head of the department, he directed many outstanding steam turbine developments, and during this period the maximum size of the company's units increased from 12,500 to 147,000 kw.

Mr. Flory was active in directing the company's efforts toward the manufacture of gas turbines, now used in the high octane gasoline program. The steam turbine activities under his direction have extended prominently into the marine field, including propulsion equipment for aircraft carriers and heavy destroyers.

Mr. Flory was a member of the A.S.M.E., A.I.E.E., Milwaukee Engineering Society of which he was a former president, the Milwaukee Athletic Club and the Westmoor Country Club.

NO! -you wouldn't accept a 10% increase in power cost without a protest

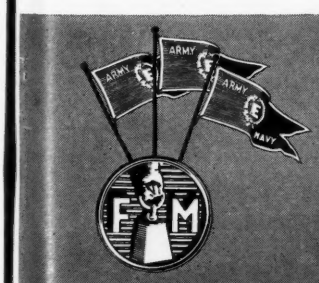


FAIRBANKS-MORSE TURBINE PUMPS

The F-M line offers complete range of capacities from 35 g.p.m. to 4000 g.p.m., for electric motor, Diesel or gasoline engine, or steam turbine drive. Open or closed impellers. Oil or water lubrication.

A SUDDEN boost of 10 per cent in power rates? You'd call it ridiculous—but many ten-year-old pumps of certain types, *even if as good as new,* take 10 per cent greater toll at the meter than today's Fairbanks-Morse models! And a 10 per cent reduction in power consumption is anything but ridiculous—especially now.

Before you arrange for increased power to meet heavier production schedules, eliminate power waste. Your resident Fairbanks-Morse Engineer can tell you quickly—without cost or obligation—whether or not the pumps you have are the types that exact the penalty of obsolescence. You may discover, as others have, that new pumps would solve your power problem today—and your cost problem tomorrow. Use your priority to buy for today with an eye on tomorrow's cost sheets. Write Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago, Illinois.



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DIESEL ENGINES
PUMPS
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AIR CONDITIONERS
RAILROAD EQUIPMENT

F M

Pumps

MINIMUM CRITICAL MATERIALS

. . . in this COAL HANDLING SYSTEM!

Shown above is one typical arrangement of the units in this B-B Coal Handling System.

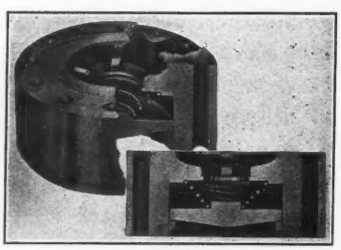
Write us today for complete details.

Designed to fill today's needs for handling coal in either new installations or oil-coal conversion, this system offers numerous advantages. Send for full information.

BEAUMONT BIRCH COMPANY
1505 RACE STREET PHILADELPHIA, PA.

MANUFACTURERS AND ERECTORS OF COMPLETE COAL AND ASH HANDLING SYSTEMS

WILLIAMS-HAGER
Flanged Silent Check Valve



- Non-Wear Conical Spring
- Renewable Disc and Seat
- Works In Any Position
- Noiseless In Operation
- Protection Against Water Hammer

These improved side-guided check valves stay tight under every condition of service and pressure. Easily installed between flanges and readily removed for inspection. Sizes up to 20 in. and for pressures to 6,000 lb. They will handle all liquids, hot or cold—water, oil, gasoline, chemicals, etc. Get further details about this economical protection for pumps and service lines.

Other Williams Specialties Pump Valves, Water Gauges, Pump Governors, Gauge Cocks, Steam Traps, Feed Water Regulators and Water Columns.

Ask for Catalog No. 142

THE WILLIAMS GAUGE CO.
3000 Pennsylvania Ave., Pittsburgh, Pa.

A De Laval-IMO *Rotary Displacement* OIL PUMP with steam-turbine drive is always ready and will run as long as there is steam pressure. The unit shown is for fuel oil booster service. It includes a worm gear speed reduction and is arranged to be mounted on a bulkhead. The turbine and gear are designed for continuous, reliable operation, having a lube oil circulating pump, combined oil cooler and filter and sight flow indicator, as well as mechanical governor and steam pressure release valve on the turbine casing. IMO delivers any oil in any volume against any pressure.

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IMO PUMP DIVISION
of the De Laval Steam Turbine Company
Trenton, New Jersey

MANUFACTURERS' NEWS

Army-Navy "E" Awards

The B. F. Goodrich Co.
Koroseal plant, Niagara Falls, N. Y.
Edison-Splitdorf Co.
West Orange, N. J.
The Ohio Injector Co.*
Wadsworth, Ohio
The Babcock & Wilcox Tube Co.
Beaver Falls, Pa. plant
Consolidated Chemical Industries, Inc.
Baton Rouge, La.
The Mathieson Alkali Works, Inc.
Niagara Falls, N. Y. plant
The Scovill Mfg. Co.*
Waterbury, Conn. plant
Jenkins Bros. Bridgeport, Conn. plant*
De Laval Steam Turbine Co.*
Trenton, N. J.

Maritime Commission "M" Award

The Edward Valve & Mfg. Co., Inc.
East Chicago, Ind.
Jenkins Bros. Bridgeport, Conn., plant

*Added star for sustained high achievement in production of war equipment.

NEWS FROM THE FIELD

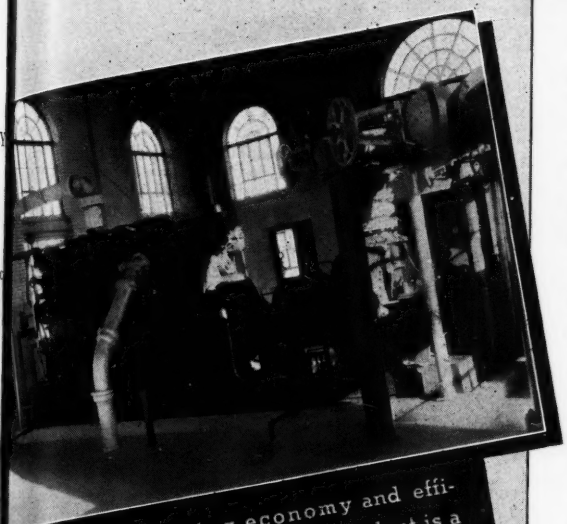
Santee-Cooper Authority to Extend Properties

A BILL is being prepared for early introduction in the South Carolina State Senate, Columbia, authorizing the Santee-Cooper Hydroelectric Authority, Charleston, a State agency, to purchase the plants and systems of the South Carolina Electric & Gas Co., and the Lexington Water Power Co., both with headquarters at Columbia, making available an appropriation of approximately $40,000,000, for this purpose. The South Carolina company operates a hydroelectric power station at Columbia, as well as a similar plant at Parr, S. C., known as Parr Shoals Hydro Plant, with rated capacities of 12,188-kva., and 18,600-kva., respectively. Company also has a steam-electric generating station at Parr, with rated output of 90,625-kva. The Lexington company operates what is known as the Saluda Hydro Plant, with rated capacity of 162,500-kva. With the approval of the acquisition, the Santee-Cooper Authority will extend transmission lines for interconnection with these plants and its Santee River hydroelectric generating plant, about 18 miles from Pinopolis, S. C.

Bonneville Administration Proposes Increase in Hydroelectric Plants

THE BONNEVILLE POWER ADMINISTRATION, Department of Interior, Portland, Ore., is projecting plans for further hydroelectric development and facilities

MADISON KEEPS THEM PRODUCING...

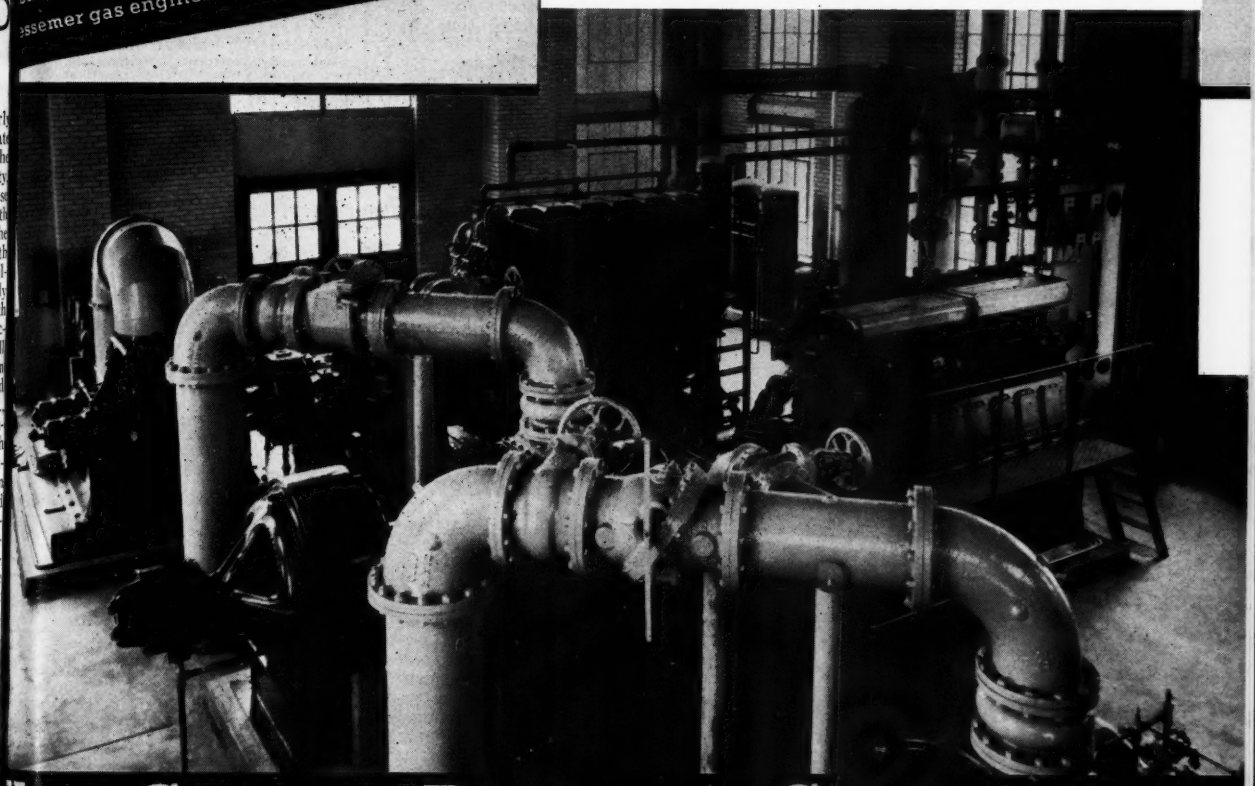


record of operating economy and effi-
ncy at the Madison sewage power plant is a
bute to the performance of these two Cooper-
ssemer gas engines—rated 230 and 320 hp.

A 60% saving in total power cost! Sufficient to pay the entire cost of the power plant in only four years!

That's the story at the Madison Wisconsin sewage disposal plant where they gradually converted from purchased power to self-produced power. No wonder they keep their two Cooper-Bessemer gas engines "producing" constantly! The first C-B engine was installed in 1937 . . . and another in 1939—both operating on sludge digestion gas.

Credit for such economy goes largely to "costless" sludge gas. Still, it's more than a question of fuel! All Cooper-Bessemer engines, sludge gas, natural gas, and Diesel, have the engineered efficiency . . . the reliability . . . and the remarkable ease of maintenance that time after time are the deciding factors in outstanding performance.



The Cooper-Bessemer Corporation

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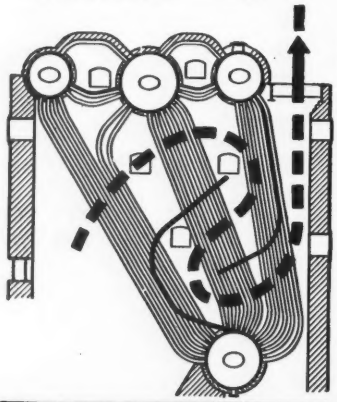
Extra Power Quickly

...and easily... with these Fuel-Saving Baffles

- Provide cross-flow of gases over tubes for maximum heat-transfer
- Tapered gas passes and curved surfaces streamline the gas flow and maintain gas velocity for efficient heat-extraction
- Draft losses materially reduced by elimination of eddy currents, bottlenecks and dead gas pockets
- Less steam used in cleaning because soot blowers are used less often, and more effectively
- Applicable to any design of water-tube boiler, fired by any fuel
- Each installation is designed on the basis of 25 years experience in this specialized branch of engineering
- Installed by skilled mechanics

Ask for bulletin BW 40 giving valuable data on modern baffle-wall constructions — free



THE ENGINEER CO.
Enco 75 West St. New York, N. Y.

to be embodied in early report to be made by Paul J. Raver, administrator. It is proposed to begin work at early date on a new power dam at Umatilla Rapids on Columbia River, with hydroelectric generating station to augment present power supply. Surveys are under way for development. No estimate of cost has as yet been announced, nor estimated capacity of proposed plant. It is expected that the project will require about 36 months for completion. It will include transmission lines for connection with Bonneville high-tension system, switching stations and other facilities. A second project also is planned in connection with existing hydroelectric power station at Rock Island, near Wenatchee, Wash. This plant has a present installed capacity of 60,000 kw., divided into four generating units. It is planned to install eight additional hydraulic turbines at the plant, each, it is understood, to be of 15,000-kw. rating, making an increase of 120,000 kw. in station capacity. Likewise, no estimate of cost of this program has as yet been announced. This expansion is scheduled for early construction.

Cooper-Bessemer to Develop Employe Education

To HELP enterprising workers of both factory and office attain more responsible positions in the company, The Cooper-Bessemer Corp., Mt. Vernon, O., and Grove City, Pa., recently announced a training plan for developing employes' education along specific lines.

According to Ralph L. Boyer, the corporation's chief engineer, who worked out the details of this program, the idea is in line with Cooper-Bessemer's policy that employes should be encouraged to further their education and thus fit themselves for advancement in the war industries. This also minimizes the shortage in skilled labor.

These arrangements were made possible through the cooperation of the regional head of the Office of Engineering, Science and Manual Defense Training, Ohio State University, Columbus, O. The subjects, chosen from a list of government approved Extension Defense Courses, as presented at Ohio State University, cover fundamental engineering drawing, and the engineering essentials of tool, jig and fixture design. Instruction is under the supervision of two veteran employes of the Cooper-Bessemer Corp.; one a recognized draftsman and the other an expert tool designer.

City of Omaha to Secure Authority to Purchase Nebraska Power Company

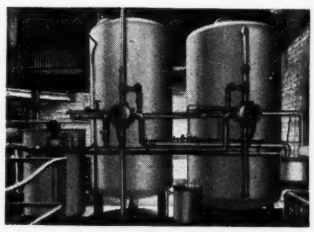
A BILL is now being considered by the State Legislature, Lincoln, Neb., authorizing the City of Omaha to purchase the Nebraska Power Co., with headquarters at that place, said to be the last privately-owned public utility company in the State. The company produces 60 per cent of the electrical energy in Nebraska. It is said that the measure will soon be adopted by the Legislature, making possible for the municipality to engage in the power business on a broad scale, serving a large group of cities and towns in that area. Under the terms of the proposed law, a commission of six members is to be chosen by the mayor and city council, selected on a non-

BOILER FEED-WATER TREATMENT ENGINEERED BY ILLCO lowers operation costs!

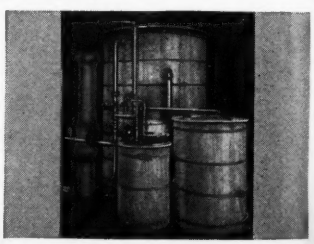
Economical to install, easy to operate, *external* treatment plants have been engineered by ILLCO for a wide variety of boiler feed-water problems. Equipment removes the detrimental constituents of the raw water at a cost which is less than that of older, inferior methods. Any desired alkalinity can be established and maintained.

CONSTANT WATER QUALITY

ILLCO External Treating Equipment produces water of a constant quality without continual supervision.



MACHINE TOOL PLANT ILLCO Duplex Feed-water Treatment Unit, blending sodium zeolite water with hydrogen zeolite water to produce a boiler make-up with zero hardness and with very low total solids and alkalinity.



MILK PROCESS PLANT Single-tank ILLCO Combination-Regeneration Boiler Feed Unit, regenerated simultaneously with salt and acid; produces same results as Duplex Equipment above. Cypress tanks avoid use of critical materials.

ZEOLITE SOFTENERS, FILTERS, AERATORS, etc. are also manufactured by ILLCO — Water Treatment Engineers. Send for complete descriptive literature.

ILLINOIS WATER TREATMENT CO.
850 Cedar St., Rockford, Illinois

TESTED IN THE LABORATORY ILLCO-WAY PROVED IN THE FIELD

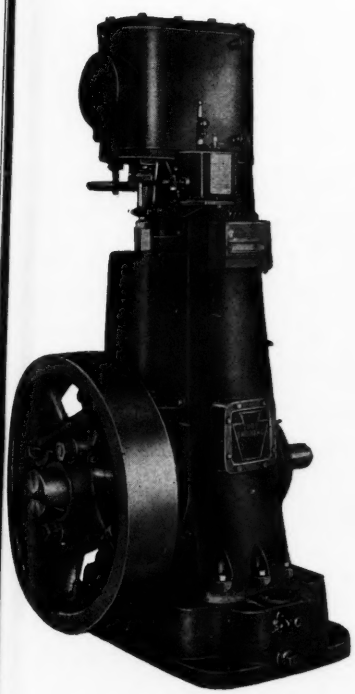
POWER *from a* TROY-ENGBERG STEAM ENGINE *is* POWER *at low cost* if most of the steam can be used for processing or heating

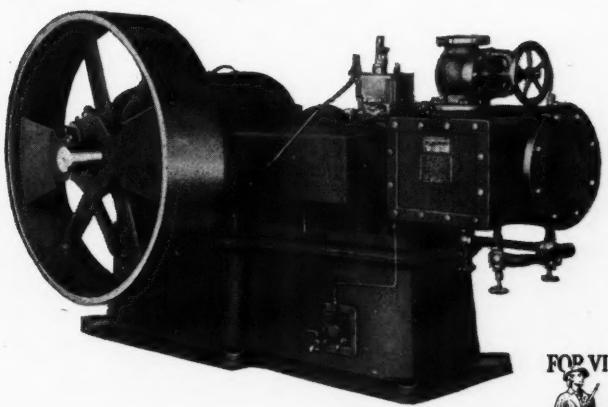
And where is the plant that cannot use exhaust steam effectively, if not for processing then for heating during, at least, a good part of the year?

Given such a condition, the Troy-Engberg Steam Engine can hold its own with any power unit on costs. In fact, it usually can show lower costs than that of any other type of drive. It can do this because it makes steam from the boiler do maximum double duty . . . supply both power and heat units.

And coupled with its low cost and unquestioned dependability are excellent drive characteristics: high-starting torque and ability to handle sustained overloads; low conservative speed often permitting direct connection to the driven equipment; susceptibility to close automatic control; and flexibility over a wide speed range.

The Troy-Engberg Steam Engine has so much to offer in the way of dependability, economy and utility, you should consider it for your plant . . . for example, to replace other drives now wearing out.



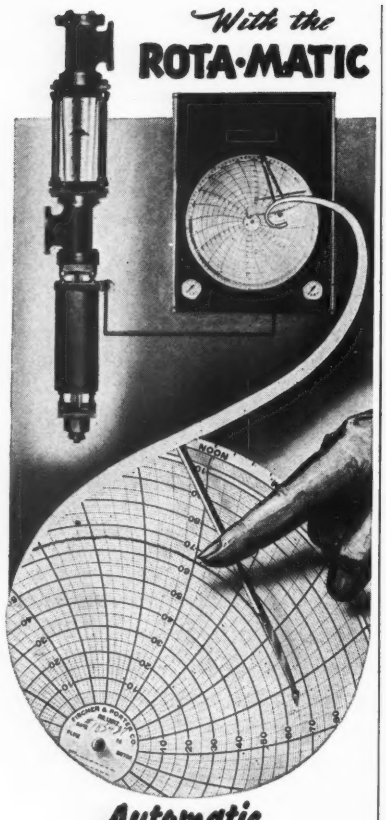


TROY ENGINE & MACHINE CO.

Established 1870

851 Railroad Ave., Troy, Pa.

4-TEM-2



Automatic
FLOW RATE
Control
is at your finger-tip!

You just set the control pointer at the flow rate desired. It is as easy as that with the "Rota-matic" to obtain automatic flow rate control.

The "Rota-matic" is a rotameter combined with a powerful, new pneumatic controller through an induction bridge circuit. Any tendency of the rotameter float to deviate from the flow control point automatically changes the air pressure upon a diaphragm motor valve placed in the flow line. In this manner, the flow rate is immediately corrected to the desired amount.

This instrument has 100% throttling range and automatic reset for perfect attunement to varying process conditions. The flow control point is adjustable *over the entire range of the rotameter.* It also provides remote recording of flow to supervise and check process results.

In the "Rota-matic" there is available for the first time a flow control instrument combining the automatic response of a modernized pneumatic controller with all the exclusive advantages of the rotameter—high accuracy, instantaneous response, low pressure loss, straight line calibration and wide flow range. It is a new tool for up-to-the-minute instrumentation by those who refuse to be hidebound by the limitations of the fixed-orifice meter. Write for Bulletin 51-B to Fischer & Porter Co.—594 County Line Road, Hatboro, Pennsylvania.

F&P ROTAMETERS

political basis. The first members are to serve for staggered terms, but when these terms expire, it is provided that future directors shall serve six years and shall be limited to two terms. The commission will have the power to construct power plants and lines, or purchase any existing publicly-owned property, with power of condemnation if a sale cannot be effected; it may acquire plants of communities adjoining those served by the Nebraska Power Co., as well as those in areas between. Provision is also made for rates of service and different features of operation, as well as authority for the commission to issue bonds without a vote of the people.

MANUFACTURERS' PERSONALS

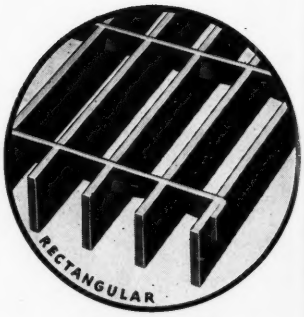
S. E. Bramer, president of Copperweld Steel Co., recently announced the appointment of William J. McIlvane as vice-president in charge of sales and assistant to the president. Mr. McIlvane was formerly general manager of sales.

Tube Turns, Inc., Louisville, Ky., recently announced the appointment of Fred C. Smith as chief metallurgist. From 1936 to the date of his present affiliation with Tube Turns, Mr. Smith was employed by Carnegie-Illinois Steel Co., Chicago, Ill., in the capacity of field metallurgist. Prior to that he was plant metallurgist for the International Harvester Co. at Fort Wayne and Chicago plants. His responsibilities will include supervision of all raw and finished materials inspection, forging operations, heat treating, and metallurgical research and service.

T. C. Wescott, engineering manager, and Harold H. Scaff, comptroller, have been elected vice-presidents of Ebasco Services, Inc., the service organization of Electric Bond & Share Co.

S. B. Taylor, works manager of the Reliance Electric & Engineering Co., Cleveland, since 1931, was elected manufacturing vice-president at a meeting of the company's directors on March 4, it is announced by Clarence L. Collens, president. Officers re-elected by the directors were Mr. Collens, president; H. Morley Hitchcock, vice-president and treasurer; A. M. MacCutcheon, engineering vice-president; James W. Corey, sales vice-president; C. V. Putnam, secretary; and H. F. Walters, assistant treasurer.

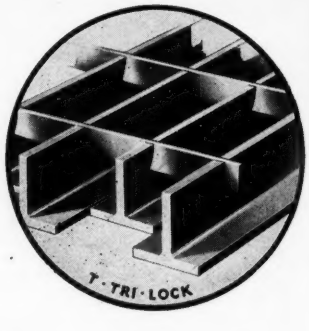
Lionel E. Moore, for the past 10 yr. an application engineer for the Westinghouse X-Ray Division, has been named X-Ray Division manager for the Portland, Ore., area. Announcement of the appointment was made by Chas. A. Dostal of San Francisco, Pacific Coast District manager for the Westinghouse Electric & Mfg. Co. In his new post, Mr. Moore will have charge of X-Ray activities for the company throughout this district. He will make his headquarters at 1210 S. W. Morrison St. where the division maintains sales offices and display rooms. He succeeds Henry D. Moreland, Portland X-Ray Division manager since 1938, who has been transferred to East Pittsburgh, Pa., as manager of X-Ray products for the Agency and Specialties Division of Westinghouse.



Specify
TRI-LOK
OPEN STEEL FLOORING
CONCRETE ARMORING
SAFETY STEPS
T. TRI-LOK

Full descriptive catalog of Tri-lok Grating, Safety Treads and other products on request.

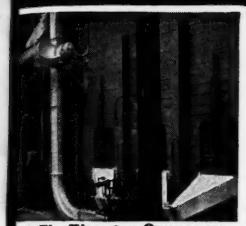
DRAVO CORPORATION
300 PENN AVENUE, PITTSBURGH, PA.
REPRESENTATIVES IN PRINCIPAL CITIES



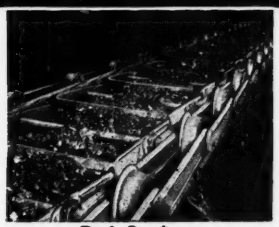
COAL IN--ASHES OUT

the *LINK-BELT* way

MEANS EFFICIENCY AND LOW COST



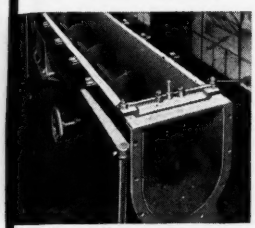
ulk-Flo Elevator-Conveyors



Peck Carriers

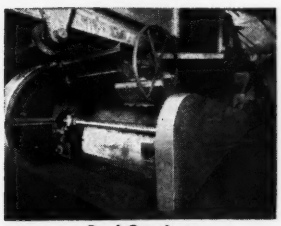
Belt Conveyors

Bucket Elevators



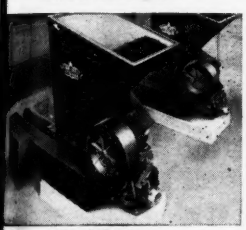
Screw Conveyors

Weigh Larries



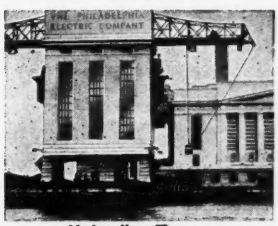
Coal Crushers

Skip Hoists



Coal Stokers

G-D Elevator-Conveyors



Unloading Towers

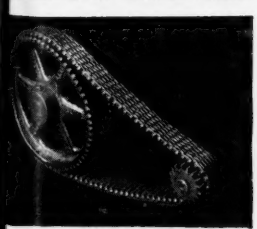
Car Spotters

Locomotive and Crawler Cranes

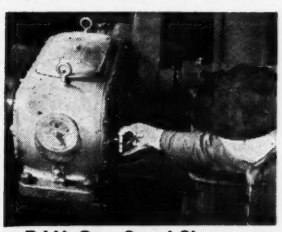
Apron Conveyors and Feeders

R.R. Car Dumpers

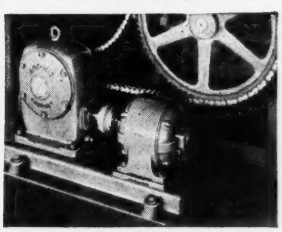
Portable Conveyors



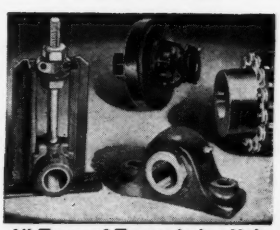
Chain Drives—All Types



P.I.V. Gear Speed Changers



Speed Reducers

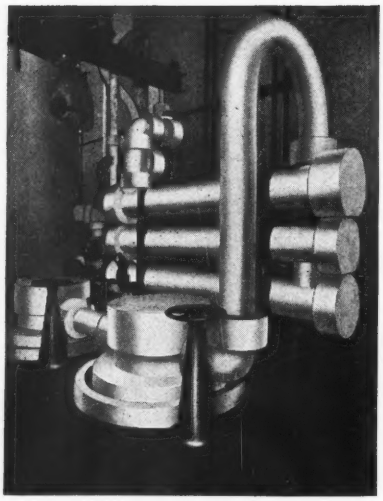


All Types of Transmission Units

LINK-BELT COMPANY

Chicago, Indianapolis, Philadelphia, Atlanta, Dallas, San Francisco, Toronto; offices, warehouses and distributors in principal cities. 8963

THROW YOUR SCRAP INTO THE FIGHT!



HENSZEY

CONTINUOUS BLOWDOWN is helping produce MORE HORSE-POWER with LESS MAN-POWER

How to get the most out of existing equipment and yet do it with fewer men than ever before is one of the many problems confronting our war production industries.

Henszey Continuous Blowdown Systems are on the job in hundreds of war production plants—helping to increase boiler and operating efficiency—helping to reduce maintenance and repairs on boilers and other allied equipment.

With a Henszey system boiler water concentration is kept below a predetermined proper safe point, continuously, automatically and without heat loss. This method of control insures clean boilers, clean water and clean steam which means:

1. **CONTINUED OPERATION**—boilers can efficiently produce maximum output for longer periods of time between shutdowns. Scale, priming, foaming and carryover are controlled.
2. **LESS MAINTENANCE** — no unnecessary man-hours lost keeping boilers clean, replacing tube burns, replacing packings, repairing or replacing rods and cylinder rings, turbine nozzles, turbine blades, reducing valves, non-return valves and other troubles.
3. **LOWER POWER COSTS**—lower cost per h.p. means fuel savings—vitally important with present and threatened fuel shortages.

Send for bulletin

HENSZEY COMPANY

Dept. C4 Watertown, Wis.

HENSZEY

POWER PLANT SPECIALTIES

T. O. Eaton has been appointed assistant manager of sales, Power Transmission Section, at General Electric's Pittsfield Works, according to an announcement by L. R. Brown, manager of the Transformer Division of the Central Station Department.

R. S. Neblett, who was assistant manager of General Electric's Turbine Division for more than 3 yr. has recently been appointed assistant manager of the company's Federal and Marine Division, it has been announced by J. W. Belanger, manager of the division.

Mr. Neblett, a native of Corsicana, Tex., has been with General Electric since 1923 when he entered the company's test course for student engineers, at Schenectady, immediately following his graduation from the Georgia School of Technology with the degree of B.S. in electrical engineering.

He joined the G-E Turbine Division in March, 1926, became manager of sales of the Schenectady section in that division in 1938, and in July of 1939 was named assistant manager of the Turbine Division. Mr. Neblett is a member of the American Society of Naval Engineers and the American Society of Mechanical Engineers.

The Magnus Chemical Co., Inc., Garwood, N. J., announces the appointment of J. D. Holmes as manager of its newly organized Feedwater Treating Division.

Mr. Holmes has had a wide range of experience in the treating of feedwater and is developing the Feedwater Division of the Magnus Chemical Co. along the latest accepted lines. Analytical methods and control features are being brought into such simple form that any engineer or fireman may maintain as accurate control over all adverse conditions found in his plant as would a trained technician.

News from the Field—guide

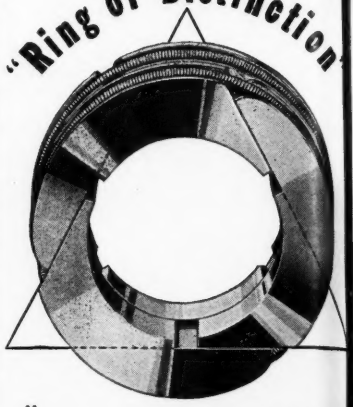
Coal Bureau of the Upper Monongahela Valley Assn., Fairmont, V. Va., will open offices in New York City at 122 E. 42nd St. with Julian E. Tobey as managing director. The Bureau serves as a clearing house for information on Fairmont-Pittsburgh seam coal, supplies fuel engineering data, and assists in the economical utilization of fuels.

Chas. T. Main, Inc., Architects-Engineers, 201 Devonshire St., Boston, Mass., announce the election of W. M. Hall as a director of the corporation.

Cuyler S. Patton of the American Locomotive Co. was elected president of the Tubular Exchanger Manufacturers Assn. at the annual meeting held last month in New York City. Mr. Patton has been prominent in the activities of the association for many years and has served several terms on its executive committee. At the American Locomotive Co. Mr. Patton is manager of sales for the Alco Products Division. He was graduated from Cornell University in 1918 with the degree of Mechanical Engineer. He has been with the American Locomotive Company since 1929.

The L. H. Gilmer Co. of Tacony, Philadelphia, Pa., have made two new territorial appointments. Joseph C. Jennings becomes technical field manager for Texas and in charge of the Houston Branch. Mr. Jennings comes from the Gilmer factory in Philadelphia where he had been connected with the Industrial Service Department. Previous to coming

"Ring of Distinction"



Install FRANCE Metal Packing for "'Round-the-Clock" Production

The renewal of ordinary packing every few weeks or months increases horsepower and production costs.

Minimum friction is encountered with France Metal "Ring of Distinction" Packing. No undue force can be exerted on rods or stems by tightening the stuffing box stud nuts. The rings are free to float in the case that retains them and are held to the rod or stem with a garter spring having minimum tension.

The result is tight "full-floating", trouble-free performance *for years.* Prompt delivery assured.

FREE

44-page Catalog of useful and valuable information. Write for your free copy of Catalog M-5, with facts on

- **Packing Designs for Any Service**
- **Installation Procedure**
- **Methods of Lubrication**
- **Pressures and Temperatures**
- **Oil Return and Stripping Rings**
- **Handy Reference Tables**

Request France Engineers to analyze your packing requirements. There is a representative close at hand.

THE FRANCE PACKING COMPANY

Tacony, Philadelphia, Penna.

Branch Offices in Principal Cities

Original **FRANCE METAL PACKING**

WHAT *a Whale of a Difference* A GOOD BRICK *Makes*

Crystolon Bricks—after three years' service—are still in A-1 condition, good for many more years of uninterrupted service.

Ordinary bricks—after three years in the adjacent heating boiler—are in very poor condition, will cause a troublesome "shutdown."

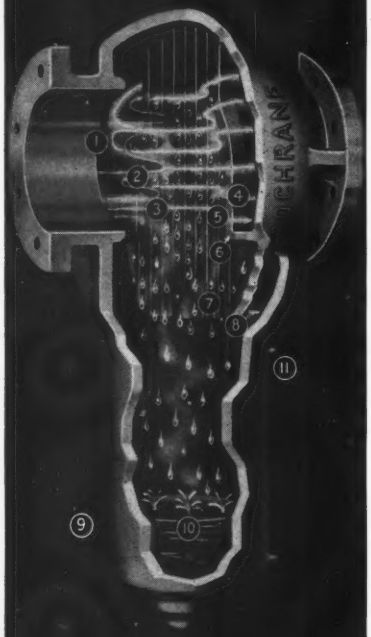
Crystolon Bricks are particularly resistant to high temperatures and to the chemical action of molten slag. Because of exceptional density they resist the penetration of molten ash. Their ruggedness enables *Crystolon* Bricks to resist the abrasive action of ash and the motion of the fire bed in stoker-fired furnaces.

R-816

NORTON COMPANY—Worcester, Massachusetts

NORTON ELECTRIC FURNACE FUSED **REFRACTORIES**

COCHRANE
ALL-SERVICE
SEPARATOR



1. Exceptional Port Area
2. Complete Removal of Entrainment
3. Self Cleaning
4. Purified Steam or Air Does Not Contaminate Entrainment
5. Steam or Air is Whipped Sidewise by Ports at Side of Baffle
6. High Ribbed Edge of Ports Prevents Entrainment Passing Baffle
7. Entrainment has Direct, Unrestrained Fall
8. Separating Shell
9. One Piece Construction
10. Condensate Chamber of Large Capacity
11. Provision for Gage Fittings

COCHRANE CORPORATION
3106 N. 17th ST. PHILADELPHIA

with the Company he had been in charge of the Mill Supply division of a distributor of Gilmer products.

Richard L. Acton is now technical field manager for Minnesota. Mr. Acton joins the Company with 5 yr. experience on power transmission products, and will make his headquarters in Minneapolis.

Feedwater Training Course

AN INTENSIVE five-week course in boiler feedwater treatment has recently been conducted by the U. S. Maritime Service, assisted by the American Colloid Division of E. F. Drew & Co., Inc., in training civilians for merchant marine positions.

The course, presented at the U. S. Maritime Service Training Station at Sheepshead Bay, Brooklyn, New York, and supervised by Lieutenant Commander J. D. Kelly, U.S.M.S., and Lieutenant F. J. Brady of the Engine Training Division, was designed to furnish merchant marine instructors with full data regarding the treatment of boiler water on Liberty ships. This course was part of the continued training program for these instructors.

Lectures, blackboard demonstrations and actual tests were features in this course which included sampling, testing, interpretation of analysis, application of treatment, and visual control of water conditioning.

Adam Cook's Sons, Inc.

THIS YEAR Adam Cook's Sons, Inc., of Linden, N. J., is celebrating its 75th anniversary. That means that for three quarters of a century Albany grease and Albany lubricants have been available to industry as the product of one company with the descendants of the founder still at the helm of active management.

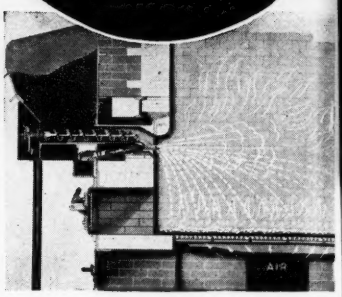
The original Albany grease was first used on Hudson River tug boats in 1868 and made such an enviable reputation for its effectiveness that it became recognized throughout the marine trade as particularly adapted to the type of equipment used in vessels. The Medal of Merit was awarded Albany grease at the Centennial Exposition held in Philadelphia in 1876; again in 1886 Special Award was received at the World's Cotton Centennial Exposition, New Orleans.

Automotive lubrication was pioneered by Adam Cook's Sons, in 1905 with the leading car manufacturers. In 1917 the mass production needs of war industries were met by the development of special lubricants. These new developments took into account the enlargement of power plant equipment and prime movers generally.

In the present war, Albany lubricants, which have gone through the pioneering stage are meeting the highly specialized requirements of the fighting forces. They serve tanks and planes, and include many specially developed lubricants for the processing of naval shells, aviation engines and many other war requirements.

Few American business firms have survived the 75-year period in the manufacture of an industrial specialty such as lubricants, which, of necessity, have had to undergo continuous improvements or modifications to meet changes in lubricating requirements. Adam Cook's Sons, Inc., therefore, is to be congratulated not alone on its anniversary but more particularly on its many accomplishments in lubricating industrial machinery.

Change over NOW— Oil to Coal!



FYR-FEEDER
MULTIPLE SPREADER STOKERS

FYR-FEEDERS meet *every* wartime firing problem. Every Fyr-Feeder feature is a direct aid to today's situation. No other method of firing can offer all these advantages:

BURNS COAL LIKE OIL—Fyr-Feeders burn fines in suspension; spread coal over entire fuel bed, burning larger pieces on grate.

USES ANY COAL—Local coals, cheap coals, screenings or sweepings.

SAVES LABOR, EASY TO OPERATE—Anyone can operate a Fyr-Feeder

INCREASES BOILER CAPACITY—And produces steam quicker.

SAVES MONEY—Helps meet higher costs and taxes.

WRITE FOR CATALOG

Many other Fyr-Feeder advantages described in new catalog. Take the right step toward conversion today —WRITE.

AMERICAN COAL BURNER CO.
Engineers, Est. 1918
22-18 E. Erie St. Chicago, Ill.

FLASH!

A New Dust Collector Made of Non-Critical Ceramic Fire Clay

As steel is badly needed for war production, the Thermix Ceramic Dust Collector—designed and built by the Prat-Daniel Corporation—is now constructed entirely of materials not essential to the war and it can, therefore, be delivered without a priority.

This sensational new Thermix CERAMIC Dust Collector has a series of 6" precipitating tubes made of special tough fire clay which is even harder than the steel tubes used in previous models. These tubes are thick and rugged so that they will not be injured by normal handling or temperature changes. But if accidentally damaged, they can be inexpensively and quickly replaced with standard shapes from our stock.

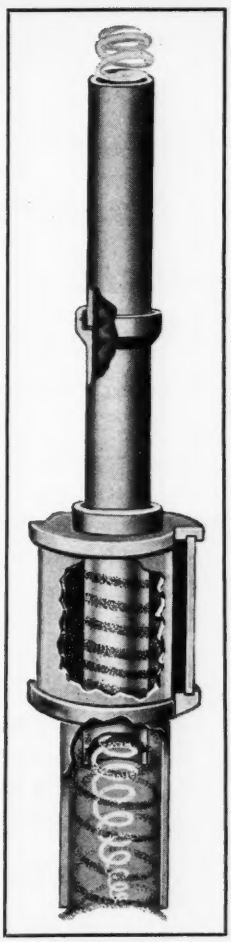
These ceramic tubes weigh no more than steel tubes and they permit installation of the Thermix Ceramic Dust Collector outside the plant without a protecting structure.

Due to its compact design, the Thermix Ceramic Dust Collector fits readily into small space.

Throughout, the design follows closely that used in Prat-Daniel's standard steel Thermix Tubular Dust Collectors now in operation with over 40,000,000 lbs. of steam capacity per hour.

It assures the high efficiency collection of practically all fine dusts, powders and pulverized fuel fly-ash.

Write for full particulars or mail the coupon.



PRAT-DANIEL CORPORATION, Port Chester, N. Y.

General Sales Agents

Thermix Engineering Co., Greenwich, Conn.

Representatives in Principal Cities

Thermix Ceramic DUST COLLECTOR

Prat-Daniel Corp.,
86 S. Water St., Port Chester, N. Y.

Without obligation on our part, you may send details about the Thermix Ceramic Dust Collector.

NAME.....

ADDRESS.....

CITY.....STATE.....

More Steam with XZIT

FIRE SCALE and SOOT ERADICATOR

Effective regardless of type of boiler or fuel used . . .

•

Have you overlooked the benefits of XZIT? An easy to use, scientific chemical compound, that frees imprisoned power . . . that steps-up operating efficiency! XZIT not only provides a simple, sure method of removing soot and fire scale from boiler heating surfaces, uptakes, breechings and stacks, it discourages any further formation of carbon deposits . . .

XZIT IS APPLIED WHILE YOUR BOILERS OPERATE!

INVESTIGATE TODAY!

Write for complete information concerning the advantages of using XZIT.

XZIT SALES CO.
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New Combustion Engineering Manager

A. B. OPENSHAW has been appointed manager of the Chicago District Sales Office of Combustion Engineering Co., Inc., succeeding James D. Harrison, recently deceased. Mr. Openshaw joined the company in 1924 and in the intervening period has been engaged in sales work in the Boston, Cincinnati, Pittsburgh and Chicago territories. More recently he was attached to the Hedges-Walsh-Weidner manufacturing division of the company as assistant to A. J. Moses, vice-president and general manager of that division.

Lamme Medal Awarded to Joseph Slepian

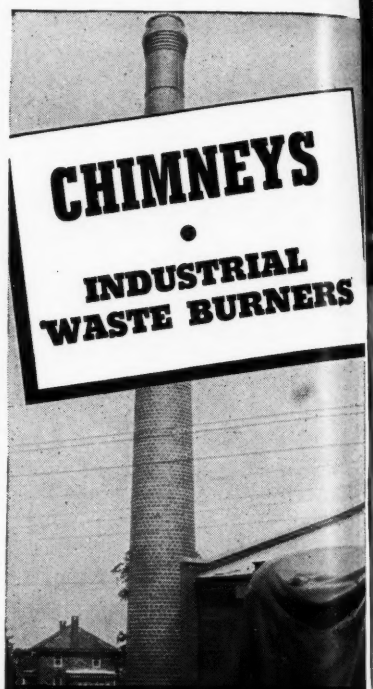
THE 1942 Lamme Medal of the American Institute of Electrical Engineers has been awarded to Dr. Joseph Slepian, Associate Director of Research, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., "for his contributions to the development of circuit interrupting and current rectifying apparatus." The medal and certificate will be presented to him at the National Technical Meeting of the Institute, which is to be held in Cleveland, Ohio, June 21-25, 1943.

Dr. Slepian, who was recently appointed an associate director of research in the Westinghouse organization, was born in Boston, Mass., on February 11, 1891. He was graduated from Harvard University with a degree of Bachelor of Arts in 1911, and received the Ph.D. degree from that institution in 1913. He spent the next year in study abroad at the University in Gottingen and at the Sorbonne in Paris.

Returning to the United States, he taught mathematics at Cornell University 1914-15, and then entered the student course given by Westinghouse. Since 1916, he has been a member of the staff of the research laboratories of that company.

Dr. Slepian has specialized particularly in the development of electrical apparatus involving arc phenomena, and has made some of his major scientific and engineering contributions in connection with the development of auto-valve lightning arresters, deion circuit breakers, high voltage fuses, ignitrons, and mercury arc rectifiers. In addition to making many inventions, and adding greatly to fundamental knowledge, he has rendered valuable services as a consultant to the engineering departments of the company.

He has written many scientific and engineering papers which appeared in the journals of the American Mathematical Society, American Physical Society, American Electrochemical Society, American Institute of Electrical Engineers, and in other publications. He is a member of the societies mentioned above and also of the American Association for the Advancement of Science.



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Municipal Power Plant in Ohio requires the temporary services of an experienced power plant engineer to set up power plant management system and train present personnel in the operation of a modern power station. Plant consists of stoker and pulverized coal fired boilers. Applicant must be a good combustion man, familiar with the latest automatic controls, modern feed water treatment, turbo-generator, and condensing equipment. New plant 75% complete, and in operation. State salary expected, and if services available at once. All inquiries will be acknowledged, and held in strict confidence. Address Box 1416, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

WATCH ENGINEER

Experienced, capable, sober and reliable man for steam turbine electric plant in a City of the South. High school graduate, or better, preferred. Drifters and seekers for high wartime pay rates need not apply. If you are looking for a normal position, at good rates, give names of references, age, family situation, draft classification, education and full outline of experience in first letter. References will not be contacted until your permission is given. Address Box 1417, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

HELPFUL BULLETINS

Practical answers to many wartime problems of plant operation and maintenance are found in the engineering bulletins offered by manufacturers. For your convenience we publish the following summary of helpful literature available. To obtain copies of the bulletins and catalogs described, simply indicate the paragraph numbers on coupon on next page, detach and mail.

BOILER PLANT EQUIPMENT

1 Stoker Operating Data—Due to unique grate construction it is claimed Stowe Stokers will burn entire range of bituminous coals at high efficiency. New catalog gives specifications and performance data. The Johnston & Jennings Co.

2 Spreader Stokers—Bulletin No. 78 describes the Fyr-Feeder multiple spreader type stoker under the theme "burns coal like oil." The principle of the multiple spreader stoker is included with detailed illustrations and installations. American Coal Burner Co.

3 Integral Furnace Boiler — Illustrated Bulletin G-34 gives complete data on integral furnace boiler, either stoker firing or oil burning. Can be quickly converted to burn whichever is the more economical fuel. Outstanding features of this unit are described in detail and cross sectional views show typical installations. The Babcock & Wilcox Co.

4 "Stoker Data and Specifications" —is the title of an attractive publication telling you how to determine correct stoker sizes and how to specify stokers. Also contains stoker dimensions, coal-burning capacities and recommended setting heights for different types of boilers. Combustion Engineering Co., Inc.

5 Heavy-Duty Stokers—20-p. bulletin features Iron Fireman Poweram heavy-duty stokers for boilers developing up to 400 hp.; outlines features of these stokers, shows actual installation photographs and lists representative users. Iron Fireman Mfg. Co.

6 Boiler Damper — The Heacon Damper, a roller-curtain type of damper for controlling flow of gases, is described in detail in a 4-p. bulletin. Details of construction and installation, data on clearance, balance, power requirements, draft loss and flow characteristics and performance are presented. Thermix Engineering Co.

ELECTRICAL EQUIPMENT

7 Magnet Wire—"Formex" magnet wire is described in a new 28-p. booklet (GEA 3911) recently made available. Formex wire is an insulated wire that is used in magnet coils. The insulation used on this wire is a synthetic polyvinyl-acetal type of resin of high dielectric strength, tough in texture, resistant to moisture and with excellent high temperature characteristics. It saves space, is easy to wind and makes smooth looking coils. General Electric Co.

8 Motor Care—New handbook entitled, "A Guide to Wartime Care of Electric Motors" meets pressing problem of how to keep motors running under continuous service conditions. Taking a fresh slant on care of motors under war conditions, the book should prove of value to engineers and maintenance men and in training new operators. The handbook is an impartial study of all motor types. Allis-Chalmers Mfg. Co.

9 Lighting — A new Government manual and price schedule on Birdseye lamps and lighting has just been issued for distribution to Government procurement agencies, purchasing personnel, and Government lighting engineers. Birdseye Electric Corp.

10 Circuit Breakers — For lighting, distribution and power circuits up to 600 amp. the complete line of Nofuze De-ion circuit breakers is described in a new 40-p. booklet DD-29-060. De-ion breakers are available for panelboards, switchboards, built-in applications, individual mountings and separate enclosures. Principles of the De-ion arc quenching action are explained, and quick facts are given on design and operation of each breaker. Westinghouse Electric & Mfg. Co.

11 Handbook on Fuses—This book shows you how to reduce electrical outages and tells you how to get more service out of your fuses. Chockfull of money-saving data that will enable you to save material and cut costs on motor installations. Bussmann Mfg. Co.

12 Transformers—Power and distribution transformers and other electrical distribution equipment important in maintaining an efficient flow of power to vital war industries are completely described in a new 20-p. bulletin B-6186. Important wartime considerations such as the use of modern welded construction and standardization of design in order to save vital materials and provide interchangeability in installation are discussed. Allis-Chalmers Mfg. Co.

13 Wartime Conservation — This is the name of a new 96-p. booklet (B-3206) published recently by Westinghouse engineers for selecting, applying and using electrical equipment so as to achieve the best possible output with the greatest saving in critical materials. The book covers up-rating of motors, thermal temperature loading of transformers, industrial network systems, line equipment and materials as practiced in the Westinghouse plants. Westinghouse Elec. & Mfg. Co.

FANS, PUMPS AND COMPRESSORS

14 Compressors and Vacuum Pumps —New bulletin C-5 describes a line of rotary compressors and vacuum pumps. Capacities to 1800 C. F. M., actual free delivery, pressures to 125-lb. —vacuums to 29.90 in. (referred to 30-in. barometer). Fuller Company.

15 More Service from Pump Rods and Shafts—Bulletin "New Parts from Old" includes complete information on how your rods and shafts of Monel or "K" Monel metal can be built up for re-finishing by welding, spray coating or electroplating, enabling you to get more service from this equipment. The International Nickel Co., Inc.

16 Fuel Injection Pump — Bulletin 39112 tells about Ex-Cell-O Diesel fuel injection pump. Compact design, self lubrication, no adjustment of fuel distribution, are among features. Many interesting diagrams in color. Ex-Cell-O Corp.

INSTRUMENTS AND CONTROLS

17 Gages for All Kinds of Liquids—Bulletin 1037 describes a complete line of liquid level gages for measuring liquids of all kinds whether light or heavy. Dial readings can be provided in feet, inches, gallons, pounds, liters or by any other desired increment. By using these gages, accurate inventory of liquids is constantly available. The Liquidometer Corp.

18 Electrical Controls — Complete catalog carries detailed descriptions and helpful engineering information on devices including circuit breakers, switches, relays, contactors, and special-purpose devices. Square D Co.

19 Shunt Meters for Steam, Air or Gas—Bulletin 307 describes a line of mechanical shunt meters which provide a simple, direct and reliable means of tallying the dollars that flow through steam, air, and gas lines. Owing to their simple design and rugged construction, these meters require little attention while in service. Builders-Providence, Inc.

20 Automatic Combustion Control—Suggestions for the selection of automatic controls and instruments for natural draft coal firing and oil burning, forced draft hand firing and all types of stokers are given in a 16-p. illustrated bulletin, Selecting Controls for Fuel Conservation. Combustion Equipment Division, The Hotstream Heater Co.

List Items You Want On Handy Coupon On Following Page

21 Open-Channel Flow Meter—This 8-p. illustrated Bulletin No. 720 describes an open-channel meter for measuring flow of fluids in open channels, such as sewage in treatment plants. Principle of operation, details of construction and methods of installation are given. Republic Flow Meters Co.

MECHANICAL TRANSMISSION

22 Bearing Bronze — Bulletin describes Magnolia Isotropic bronze cast by a special method that makes it wear longer. 700 stock sizes, cored or solid bars, this metal is fully machined, inside, outside and on the ends. Ultimate strength, psi 31,250, yield point, psi 26,000, elongation in 2 in. 8.5%, Brinell 70. Magnolia Metal Company.

23 Power Transmission—A new 32-p. "Handbook of Modern Mechanical Power Transmission for Industry" constitutes a graphic presentation of the most recent engineering procedure in designing group drives and maintaining these drives for efficient power transmission. The handbook briefly, yet thoroughly explains the correct grouping of machines, proper engineering of drive components, correct care of belts for long time service. Cling-Surface Co.

24 Cast Tooth Sprockets—An 8-p. illustrated booklet No. 2067 lists the sizes of cast tooth sprocket wheels that are available quickly from stocks carried at Link-Belt plants and warehouses, and by distributors located in industrial centers. This includes sprockets for Ewart detachable "H" Class, SM, SS, XS, GL, "C" Class and "800" Class chains. List prices, dimensions, weights, are given. Link-Belt Co.

25 Mechanical Transmission Manual —A new V-belt catalog and instruction manual has recently been issued. This is a complete catalog on Veelos Adjustable V-Belting. It shows in detail the sequence of operations to take the belt apart at any joint with an ordinary screw driver and then shows the necessary steps to couple the belt together again without the use of any tools whatever. Manheim Mfg. & Belting Co.

PIPING, VALVES AND FITTINGS

26 Data Book on Welding Fittings and Forged Steel Flanges—This 216-p. presentation gives a wealth of information on welding fittings and forged steel flanges. Contains engineering data that will prove invaluable to the man who purchases, designs or specifies piping fittings and flanges in carbon and alloy steels. Taylor Forge & Pipe Works.

27 Pipe Bender—How thin-walled pipes and tubes can be bent cold to a close radius by the use of a revolving mandrel is described in an illustrated folder. Contains specifications and pipe bending data of value to engineers and maintenance men. Atlas Pipe Bender Corp.

28 Underground Piping — Bulletin entitled "Wrought Iron For Underground Service" is written for water works engineers, electrical and civil engineers, heating men, plant maintenance men. Discusses the most important factors effecting soil corrosion of underground piping, weighs theory against test results and outlines installation histories of water wells and lines, oil and gas wells and lines, gasoline lines and tanks, and electrical cable conduit. A. M. Byers Co.

29 Valve Data Book—32-p. booklet entitled, "Where to Use Valves, Drains and Bypasses", tells which valve to use, differences between various valves, fundamentals of valve designs and applications, where to use bypasses or drains, metal composition of Jenkins valves and lists ASME Power Boiler Code Valves. Jenkins Bros.

30 Safety Heads—How and where B. S. & B. safety heads are used to protect compressed air systems, air conditioning machines, chemical reaction vessels, storage tanks, Diesel engine crank cases, etc., is described in Catalog No. 42. Contains many installation views and useful compression tables. Black, Sivalls & Bryson, Inc.

31 Metal Hose Handbook—Bulletin No. H-201 gives complete information about Eclipse seamless flexible metal hose, widely used for handling alcohol, grease, hot liquids, oil, steam and other non-solids, where high temperature and pressures prevail, and where flexing and vibration are encountered. A helpful book for engineers, designers and specification men. Eclipse Aviation (Metal Hose Department) Division of Bendix Aviation Corp.

32 Steam Separators — Operating principle of Stickle triplex separators for oil and steam is interestingly pictured in new Bulletin No. 200. Contains specifications and prices. Stickle Steam Specialties Co.

33 Automatic Shut-Off Gages—New Bulletin No. 45 describes Ernst water gages for boilers and tanks. Extra heavy design, automatic shut-off, self-cleaning, are among gage features. Ernst Water Column & Gage Co.

34 Pipe Welding—A 16-p. well illustrated booklet covers various types of ferrous and non-ferrous piping, their dimensions, fabrication, and estimates of welding and labor costs. Air Reduction Co.

35 Boiler Room Valves — Bulletin E100 pictures and describes the installation of quick-acting Everlasting valves in water column connections, surface and bottom blow-offs, emergency oil shut-offs, etc. Contains sequence of operation, specifications and other data helpful to engineers. Everlasting Valve Co.

36 Plastic Pipe and Fittings—New bulletin tells about Saran pipe and fittings made of chemically resistant thermoplastic resin. Contains valuable data on Saran pipe characteristics—how to weld and thread it—sizes, weights and bursting pressures. Hodgman Rubber Co.

PRIME MOVERS

37 Turbines, Engines—Bulletins describe a complete line of turbines, engines and boilers and includes specifications and dimensional data on types to meet all requirements. Murray Iron Works.

38 Gas Engines—Bulletin No. S-550-B21 covers CCG gas engines, vertical, 4-cycle, totally enclosed, adaptable to generator, pump, compressor and other power drives. Also includes typical installation photographs. Worthington Pump and Machinery Corp.

39 Turbines — Bulletin 135 9 describes Coppus steam turbines, precision-made, controlled by Johnasson size blocks. Comes in 6 frame sizes; matching size to job. Coppus Engineering Corp.

40 Diesel Performance Data—"What Users Say About Caterpillar Diesel Power", interesting booklet by this title deals with statements users have made regarding Diesels of this company. Problems solved by Diesel applications are discussed and installations portrayed. Caterpillar Tractor Co.

WATER TREATMENT

41 Water Softeners—Bulletin 1850, 16-p., entitled Hot-Flow Water Softeners describes various types of boiler feedwater treatment equipment. Included are diagrams and general arrangement of equipment and maintenance data. International Filter Co.

42 Water Conditioning System—New Technical Water Conditioning System is completely described in a bulletin free for the asking. Specific organic formulas developed individually to fit your needs. Company engineer will inspect your plant without obligation. Water Treatment Co. of America.

43 Information on Proportioning—Data describes a system including control metering, cyclic timing, high and low pressure proportional chemical feed pumps, and automatic back flushing. Eliminates guess work in the manual adjustment of feed valves and

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revents excessive chemical loss through blow down. Proportioneers, Inc.

44 Water Treatment—"H-O-H Water Studies" is the title of a 48-p. booklet of articles on scale, corrosion and water treatment problems. Includes tables, charts and graphs on water problems occurring in cooling systems, hot water systems, boilers, and return systems including special data on corrosion inhibitors, scale preventives, protective coatings, proportioning equipment and refrigerating brine problems. D. W. Haering & Co., Inc.

MISCELLANEOUS

45 Condensate Units—4-p. Bulletin 1142 describes simplex and duplex "Series G" Schaub condensate return units. The units, compact in design, use a minimum of critical materials and can be used for a variety of condensation return requirements. Included are dimensional data and illustrations. Fred H. Schaub Engineering Co., Inc.

46 Floor Repairs—A new tough floor patch or overlay "Instant-Use" for broken, rutted floors can be trucked over immediately following installation. Bonds to feather edge. Can be used over concrete or wood. Write for useful explanatory folder. Flexrock Co.

47 Colloidal Graphite—A 4-p. illustrated bulletin. No. 422-AV, on the use of "dag" colloidal graphite as a parting compound, discusses the colloidal graphite for screw threads, lamp bulbs, its application to aviation and deep sea diving equipment, also its use in the glass industry, in the foundry, and in the rubber industry. Acheson Colloids Corp.

48 Paint—A 6-p. bulletin gives data on application of paints for interior and exterior maintenance, for improving production efficiency and labor relations through the use of paints. Included are a list of colors available to match original equipment. The Wilbur B. Williams Co.

49 Free Repair Handbook—A 40-p. guide for the use of Smooth-On cements contains 170 diagrams and instructions for making lasting and economical repairs to plant equipment and machinery, pipe lines, fixtures, etc. Smooth-On Mfg. Co.

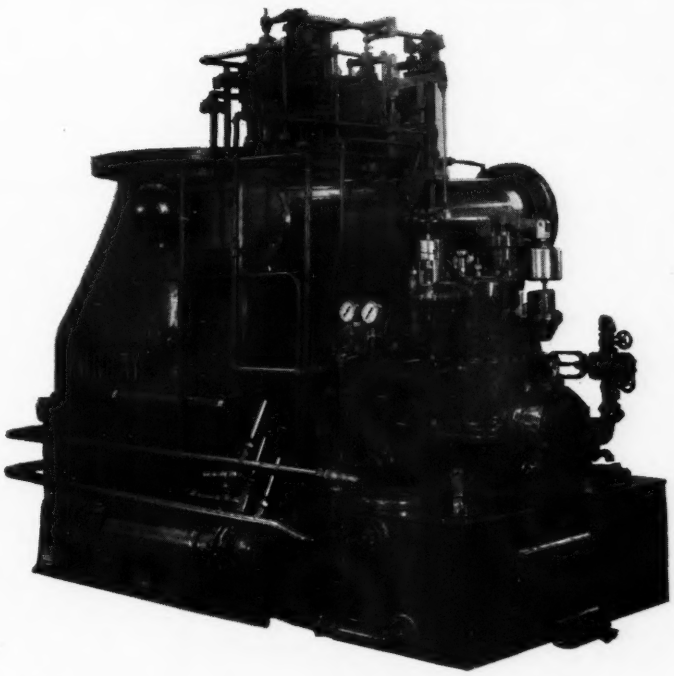
50 Packings—64-p. catalog illustrates and describes a comprehensive line of packings, gaskets, gasket and lubricating pastes, etc. Reference to text and recommendation tables will enable you to select a satisfactory material for any packing job. The Garlock Packing Co.

51 Power Check Chart—"National Power-Recovery Plan" is the title of a booklet describing a plan to stimulate the reduction of industrial power losses, whether you purchase your power or generate it. Containing a series of estimators, each relating to a certain phase of power service, you are enabled to report every possible power leak which can be corrected in various departments. L. H. Gilmer Co.

52 Welding Chart—A graphic chart for oxy-acetylene flame adjustment has been prepared particularly for guidance of new welders. The chart conveys the proper appearance of the various welding flames for quick identification. Air Reduction Co.

MURRAY TURBINES

For Air Conditioning Compressor Drive



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View shows one of many Murray Turbines designed especially for air conditioning compressor drive. This unit develops 1000 h.p. at 4 lb. initial pressure, 26 in. vacuum and 4100 r.p.m. It is equipped with variable speed, oil pump, oil relay governor; automatic nozzle control; auxiliary turbine driven starting oil pump; vacuum breaker actuated by overspeed governor; solenoid trip to stop turbine in case of abnormalites in the refrigeration system. Governor includes automatic control which maintains even temperature of the system's cooling medium by varying the capacity of the compressor through the speed. Steam inlet is 12 in. and exhaust outlet is 36 in. arranged in an upward direction.

Other Murray Turbines are driving air conditioning compressors at 8000 r.p.m., or have extraction or extraction mixed pressure gear to maintain the proper heat balance in the plant. Write for descriptive bulletin.

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ENGINEERS interested in working out the best possible liquid level control hookup will find a wide choice of units offered by Davis. The broad Davis line includes several sizes and types of float boxes, float and lever tank units, float and lever operated valves and combinations of these units for every conceivable application — direct or remote control of valves, pumps, switches, signals, indicators, etc. It may save you time and money to consult Davis first. Literature on request.

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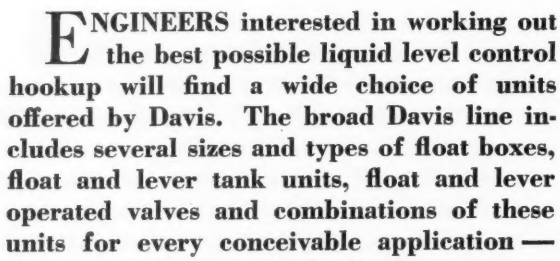
Below—Float and lever unit with Dia-Ball packless unit.



Right—No. 61 Fluid Control Valve. Tight closing. Easy opening against pressure.

Left—No. 60 Float Valve. No hunting or water hammer.

Above—No. 161D Float Box. Also available with various types of electric switches.

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S.P.A. to Meet in Pittsburgh

DR. SUMNER B. ELY, Chairman of the committee arrangi for the Pittsburgh meeting of the Smoke Prevention Ass'n be held June 8 to 11 incl. at the William Penn Hotel has a nounced a number of speakers who will take part in the me ing. The names include the following, who will address t meeting on the subjects indicated:

Henry F. Hebley, Product Control Mgr., Pittsburgh C Co., The Probability of Error in Sampling Coal.

Dr. H. J. Rose, Senior Industrial Fellow, Mellon Inst. Ind. Research, Smoke Tendencies of Coals of Various Rank

Dr. E. Berl, Research Professor, Carnegie Inst. of Tec nology, Smoke Seen Through the Eyes of a Chemist.

K. H. Bowman, Dravo Corporation, Collection of Flya from Spreader Stokers.

D. D. Pendleton, Buel Engineering Co., Determination Flyash Analysis.

W. H. Kimberly, Smoke Inspector in Charge of Railroad Pittsburgh Bureau of Smoke Prevention, Railroad Smo Control in Pittsburgh.

Navy Needs Electrical Engineers

OFFICER'S commissions in the U. S. Naval Reserve awa electrical engineers not engaged in essential war work, Ca E. S. Root, director of Naval Officer Procurement in Ch cago, announced March 23.

This appeal is not directed to electrical engineers in w industry, but to those men of the profession who wou choose to serve their country in a much more essenti capacity than they are currently engaged in.

Physical requirements for these engineers have b somewhat relaxed. Applications will be accepted in cas where these physical disorders will not interfere with th performance of duty.

Those qualified for electronics work are experienced me holding degrees in electrical, radio or communication engineering, or with background in physics and mathe matics.

Newly-commissioned officers in ultra-high frequenc work are given the Navy's three-months' course in ele tronics at either Harvard University or Bowdoin Colleg This is followed by an additional 90-day laboratory cours at Massachusetts Institute of Technology.

Qualified engineers up to 50 years of age are eligibl and applicants should visit their local Office of Naval Off cer Procurement.

Protective Lighting of Industrial Properties

INTENDED as a guide for outdoor protective lighting to thos whose responsibility it is to provide for plant protection fro theft and sabotage, a book of standards just announced by th American Standards Association sets forth the principles in volved, the chief areas to be lighted, and the minimum degre of illumination considered necessary for the detection of per sons bent on theft or sabotage. It also recommends procedur to be followed in preventing sabotage to vital buildings, struc tures or equipments. The standard is profusely illustrate with figures and diagrams as well as tables which clarify th text and graphically show the types of lighting needed fo fenced boundaries, water front boundaries, pedestrian and con veyance entrances, open yards, outdoor storage spaces, pier and docks, and vital structures. In the appendix, suggestion are given for obtaining the performance prescribed in the spec ifications.

New Engineering Books

Chemical-Technical Dictionary. By A. W. Mayer Translated under the direction of Prof. B. N. Menshutkin and Prof. M. A. Bloch. Size 5½ by 8½ ins., 872 pp. cloth binding. Published by Chemical Publishing Co., Inc. 234 King Street, Brooklyn, N. Y. Price $8.

This book is a dictionary in a limited sense only, because it does not define technical words in any one language but rather presents each word in four languages, assuming that the reader knows its meaning. The words are indexed in

German; then follow the English, French and Russian terminologies corresponding to the German. For example, to look up *steam*, the reader must know that in German it is *Dampf*. Then following *Dampf* he finds: *steam; vapeur d'eau* (French); *nap* (Russian). This is followed by the various equivalents for *high-pressure steam, dry steam, saturated steam, vapor, superheated steam* and other related words and of verbs such as *to get up steam, to vaporize, to steam* and the like.

The dictionary is of primary interest to chemists and chemical engineers, since so much of their literature is in German. But it should also be of value to power plant engineers reading foreign languages, to translators and to college students who know something of the languages involved.

Bibliography on Automatic Stations, 1930-1941. A 26-page pamphlet published by The American Institute of Electrical Engineers, 33 West 39th Street, New York, N. Y., 1942. Price, 25 cents per copy to members of the A.I.E.E., 50 cents to non-members.

This publication sponsored by the A.I.E.E. committee on automatic stations supplements earlier bibliographies on the subject published previously in the A.I.E.E. Transactions. The entries are numbered consecutively by sections and listed alphabetically by years. The material is divided into the following sections: General; supervisory and remote control; telemeter and telemetry; automatic and remote controlled switches and switchgear; automatic features of generating stations using fuels; automatic boiler and combustion control; automatic hydroelectric plants; automatic substations.

Fundamentals of Electric Waves. By Hugh Hildreth Skilling. First edition. 186 pages, 6 by 9, cloth. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1942. Price $2.75.

The subject of electric waves, as anyone who has studied physics knows, is not new but more people are conscious of electric waves these days than in previous years. Poynting showed many years ago that the energy in a conductor resided in the electric and magnetic fields surrounding the conductor. The Poynting vector is not used much in connection with ordinary electric circuits but becomes of importance in any consideration of electric waves.

The purpose of this book is to introduce electric waves. The principles of wave action and in particular, the basic ideas of Maxwell's equations are presented in a way that has proved to be understandable to students and the ideas are then discussed and used in simple examples until they become thoroughly familiar.

The first two chapters of the book are devoted to the study of electrostatics and vector analysis. As the author points out, to some these chapters will be fascinating, to others, tedious, but they are essential for one cannot have waves without electric and magnetic fields nor can one understand a wave until the basic fields are thoroughly familiar.

Physical concepts are stressed throughout the book but without overlooking either the mathematical rigor on the one hand or engineering practice on the other. A radio engineer, thus, may find the book useful in acquiring a background for understanding antenna arrays, transmission lines, wave guides, resonators, etc., whereas a physicist, having less interest in these practical uses may find the book helpful as an introduction to some more advanced work on electromagnetic theory.

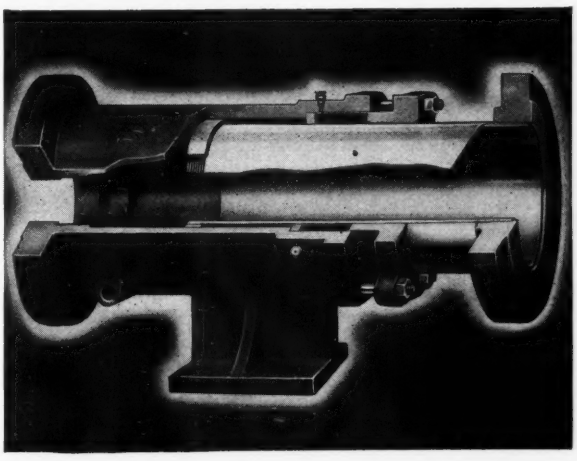
It is essentially a book for those wishing to understand fundamentals, and is designed for those who do not necessarily have any previous knowledge of electromagnetic theory. The chapters on vector analysis are presented for use in the book but it is not expected that the reader should have earlier acquaintance with it. On the whole it is a very good book for those having a fair knowledge of physics and mathematics—college physics and mathematics through calculus are enough. It is a small book, only 186 pages, and it sticks to the subject. All electromagnetic theory that does not relate to waves is excluded. Problems are given with each chapter and they are an integral part of the book. Most of them supplement some idea that is left without complete discussion in the text.

The author is Professor of Electrical Engineering at Standford University and his book is the outgrowth of his experience in teaching the subject to college students over a period of several years.

A. W. K.

Physics. By W. F. G. Swann. First edition, 274 pages, 5¾ by 8½, cloth. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1941. Price $2.25.

SOLVES SHORE OR SHIP PIPE EXPANSION PROBLEMS



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BLACKMER ROTARIES

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They handle "difficult liquids" and help you maintain your 168-HOUR-WEEK schedule, because they are *self-adjusting for wear*—no long or frequent shutdowns.

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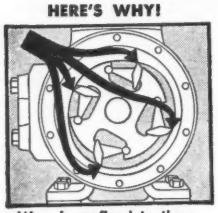
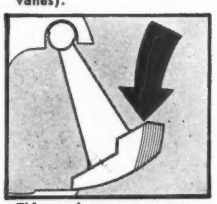
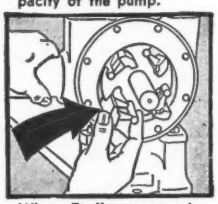


Wear is confined to these points: the tips of the "buckets" (swinging vanes).



This much can wear away, without affecting the capacity of the pump.



When finally worn out, the "Buckets" are replaced (a 20-minute job) and pump is restored to original efficiency.

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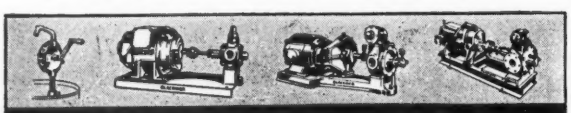

BLACKMER Rotary PUMPS
"BUCKET DESIGN"—SELF-ADJUSTING FOR WEAR

To those who know something about the author, even those who have only had the privilege of listening to one of his lectures, it need not be explained that this book is not a conventional textbook on physics; indeed it is not a textbook at all. It is, rather, an essay on physics, a survey of what physics is and how it helps us in evaluating and classifying the many processes and phenomena in nature. This book will not teach the reader all there is to know about the subject of physics but it will help him to understand what he would like to understand about the subject. As Dr. Swann points out in the preface, in the literal sense there is no teaching, there is only inspiration to learn or understand. Knowledge comes from within, outwards rather than from without, inwards. In other words, a true teacher is an inner ally working in the mind of the student to break down his resistance to a discovery of the truth and slay those various influences which are continually pulling him away from the fruitful path of his thought. In one sense, this book may be regarded as a guide to the study of physics but it is more than that, it is also a source of inspiration.

Dr. Swann's book is one of six in a series constituting a comprehensive and liberal course in science. Together the six volumes provide a coordinated study of the world we live in from the standpoint of its physical environment—the earth sciences; of the matter of which it is composed—chemistry; of the energy which makes it work—physics; of its place in the universe—astronomy; of life in its confines—biological science; and of man—as a functioning body.

The book is divided into three parts; Part I the introduction, describing the scope and purpose of physics; Part II devoted to dynamics, the study of the motions of bodies, and Part III taking up in detail the main divisions of physics, i.e., mechanics, heat, light, optics, etc. The volume should be equally useful to the average intelligent citizen in search of education, to the practicing engineer wishing to refresh his memory and to the college student in need of something to guide him in his physics courses.

A. W. K.

Combustion-Chamber Design for Oil-Engines. By Paul Belyavin. Size 5 by 7 in.. 88 p.; paper cover. Published by The Sherwood Press, Box 552 Edgewater Branch, Cleveland, Ohio. Price $1.50.

The success of every oil-engine to a large extent depends upon the design of its combustion chamber and as the process of combustion in the cylinder is invisible, designing a combustion chamber for a new engine is a matter for conjecture. This book covers an analysis of experiences with engines of many types and a study of the history of the development of combustion chamber design as an aid to a better understanding of the fundamental requirements of a rational combustion chamber.

The book is divided into eight chapters under the following headings: Historical notes on the development of combustion chamber design; the basic requirements of the design of a rational combustion chamber; heat losses during combustion, temperature of combustion and its influence on thermal efficiency; the importance of the correct shape of combustion chamber design; efficiency of fuel injection and its influence on combustion; investigation of the combustion chamber efficiency; fuel oil and its influence on smoothness of combustion, compression ratio, Diesel knock and its causes; and survey of existing combustion chambers.

A.S.T.M. Specifications for Steel Piping Materials. Prepared by Committee A-1 on Steel. Size 6 by 9 in.. 249 p.; paper cover. Published by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. Price $1.75, single copy; $1.25 for orders from 10 to 49 copies.

For the first time, the American Society for Testing Materials has compiled in one volume all its specifications covering steel piping materials, most of which were developed through the work of Commttee A-1 on Steel. There are ten specifications covering boiler, superheater and miscellaneous tubes, 15 covering various types of pipe for service at normal and elevated temperatures, five on still tubes for refinery service and heat-exchanger and condenser tubes, five covering castings used for valves and related materials, four pertaining to forgings and fittings, three on carbon and alloy-steel nuts and bolting material, and the standard austenite grain size chart E 19 is incorporated in the book. Also the many A.S.T.M. emergency alternate provisions issued in the piping field to expedite procurement and to conserve critical and strategic materials are included.

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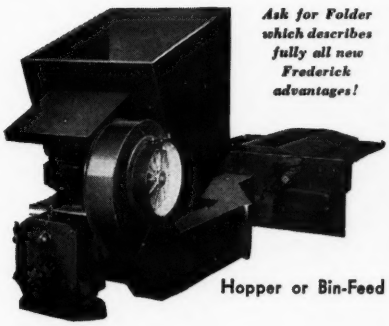

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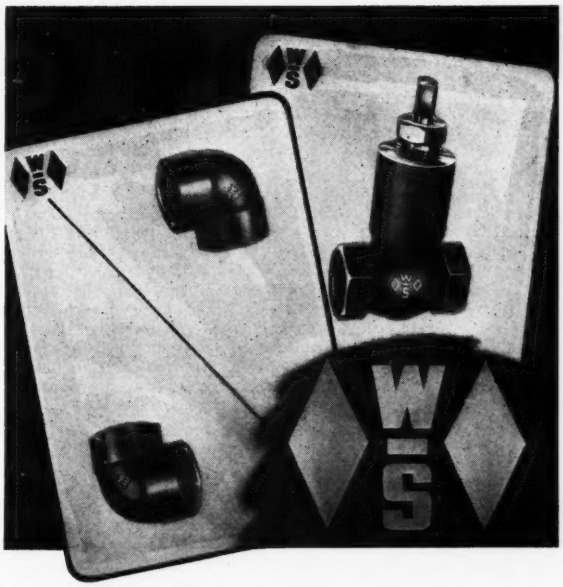

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Nearly all the material in the book has been developed from an elementary point of view to facilitate rapid absorption. Some mathematical derivations are given for all formulas, but they appear in appendices at the end of each chapter where they do not interfere with the smooth development of the subject matter in the text. The problems are analyzed by the steady-flow energy equation by which the most complex problems in air conditioning can readily be worked out.

The book is divided into 21 chapters under the headings of Fundamentals, Enthalpy of Air-Vapor Mixtures, Moisture and Heat Balances, The Psychrometric Chart, Moisture Ratio and Ratio Lines, Adiabatic Mixtures of Air with Water, Steam or Ice, Humid Air Below 32 deg. F., Fogged Air, Air Mixtures, Specific Volume of Humid Air, Required State and Volume of Conditioned Air Supply, By-Passed Air, Steep Ratio Lines, Capacity of Refrigerating Plant, Methods of Reheating Air, Air on Contact with Water, Temperature of Adiabatic Saturation, The Water-Air Chart, Fundamental Simultaneous Conditioning Processes, Fundamental Successive Conditioning Process, Geometry of Psychrometric Chart, and there are 32 psychrometric tables and 7 psychrometric charts contained in a pocket in the back of the book.

A Study of Chert as a Deleterious Constituent in Aggregates. By Harold S. Sweet and K. B. Woods. Size 6 by 9 in., 112 p., paper bound. Published as Research Series No. 86 by the Engineering Experiment Station, Purdue University, Lafayette, Ind. Price 50 ct.

Chert is "any opaque natural micro-crystalline or microaphanitic silica whose structure and environment do not permit it to be otherwise classified." It is generally recognized that some types of chert are deleterious in concrete aggregates because of their lack of durability. This causes "popouts" and other forms of disintegration in concrete. Recognizing the harmful effect of some types of chert, the various states have developed specifications limiting the amount of chert in concrete aggregates. The states particularly concerned about chert are those in the Middle West including Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio and Wisconsin.

The study reported in this bulletin was begun because of the confusion that existed among engineers regarding the deleterious properties of chert in mineral aggregates. The types that are deleterious had never been defined satisfactorily and the methods of identification were inadequate. The study has been carried on as a cooperative investigation between the Bureau of Tests and Materials State Highway Commission of Indiana and the Joint Highway Research Project. The bulletin presents first a general discussion of chert, review of previous investigations, collection and classification of samples, tests on quarry cherts, discussion of gravel cherts, miscellaneous tests, discussion of results and major conclusions. The report closes with an extensive bibliography and two appendixes.

Save Fuel for Victory. Size 6 by 9 in., 35 p., paper bound. Published as Circular Series No. 47 by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Price 35 ct.

This booklet contains a series of non-technical articles about insulation, heating-plant efficiency, and related subjects, originally presented as talks over the University of Illinois Radio Station WILL by members of the staff of the Department of Mechanical Engineering in the College of Engineering, and the Engineering Experiment Station of the University.

Ripper's Heat Engines. Revised by A. T. J. Kersey. Size 5 by 7½ in., 337 p., cloth bound. Published by Longmans, Green and Co., Inc., 55 Fifth Ave., New York, N. Y. Price $1.60.

Because the steam turbine and internal combustion engine are rapidly taking the place of the reciprocating steam engine as the principal prime mover both in land and marine practice, a revised edition of this popular textbook was necessary. This new edition is brought up to date by the addition of new material and omission of obsolete and out of date material. Although it covers English practice primarily, it is applicable to American practice and its clear explanation of essential principles and outline of their main applications meet the needs of a large number of students.

The book is divided into 20 chapters covering heat and all its phases, steam, steam engines, valves, gears, cranks, condensers and governors, locomotives, compound engines, boilers, fuels and combustion, steam turbines and internal combustion engines. In the back of the book are 16 pages of examples and their answers.

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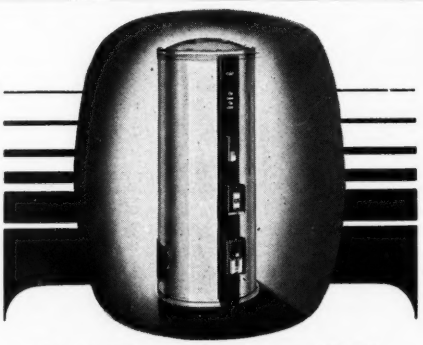

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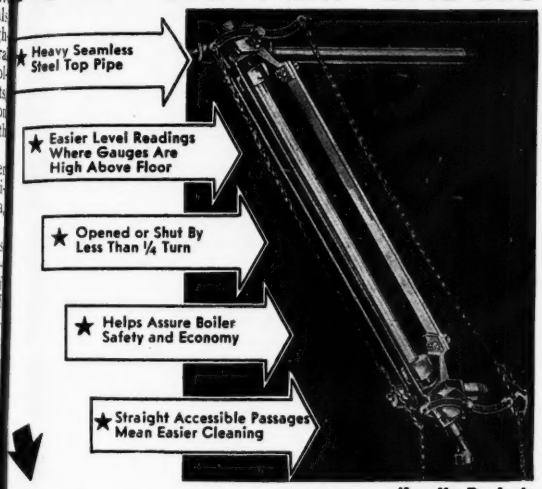
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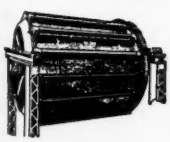

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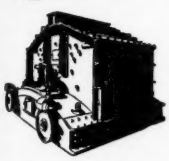

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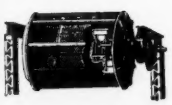

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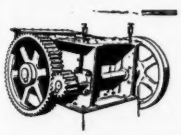

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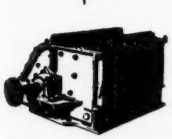

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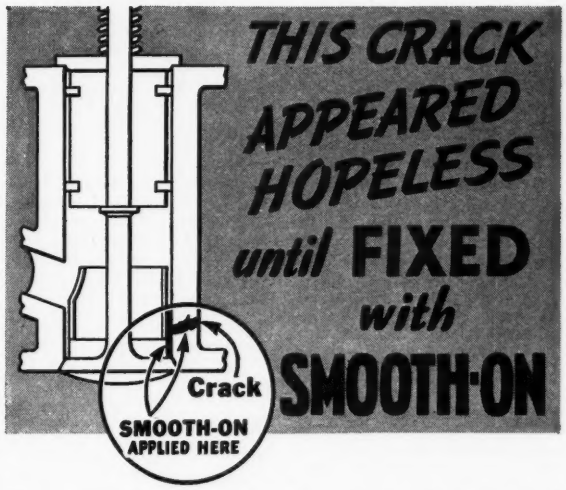

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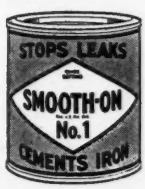

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The Organization and Training of Industrial Fire Brigades. By Captain John C. Klinck. Size 6 by 9 in., 128 p., 150 illustrations. Published by S. C. Toof & Co., 195 Madison Ave., Memphis, Tenn. Price $1.

This book has been prepared especially for use by fire department officers confronted with the problem of organizing and training fire brigades within industrial plants, storage warehouses and other large buildings to safeguard business and industry against the hazards of fire and other destructive elements during the war emergency. The book was prepared by a group of experienced fire officers as a text for a 34-hr. course of training in the fundamentals of fire fighting. It is written in simple, non-technical language.

The book is divided into 24 chapters covering the method of setting up a fire brigade program, firemen's personal equipment, fire extinguishers, tools and equipment, forcible entry, ventilation, standpipes, sprinkler systems, private fire alarm systems, plant inspection, evacuation, emergency communications, zoning of industrial areas, sabotage, defense against bombs and gas, rescue work and salvage operation.

Foremanship and Safety. By C. N. MacMillan. Size 5 by 7½ in., 101 p., spiral bound paper cover. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. Price $1.

This book has been prepared as a simple, direct approach to the foreman's safety problems and follows the fundamental principles and accepted axioms of industrial safety. It is intended as an easy reference that will not only help in foreman training but will also aid in solving the foreman's daily safety problems. In wartime, production with safety may well be the deciding factor in the conflict. Production without safety may be as direct an aid to our enemy as actual sabotage. Accidents cost American industry in 1939 enough time to build 40 battleships, and there is no one in a better position to cut down this excessive loss than the foreman.

The book is divided into 27 chapters covering all phases of safety precautions and each chapter is followed by prepared talk which can be used as pep talks by forem in any type of plant.

Engineering Mechanics. By Bevis B. Low. Size 5½ 8½ in., 252 p., cloth bound. Published by Longmans, Gre & Co., Inc., 55 Fifth Ave., New York, N. Y. Price $4.

This book is intended as a textbook for engineerin students and was prepared as a companion volume D. A. Low's Applied Mechanics. Each book is comple in itself but together they cover a wide field. This ne work is concerned chiefly with kinematics and dynamic Deflection of beams is also dealt with, since some knowled of this is required in the study of certain vibration problem

The book covers English practice although it is equall applicable to American practice. Its 11 chapters cove velocity and velocity diagrams, analysis of velocity an acceleration, acceleration diagrams, force, torque, work an energy, dimensions, simple harmonic motion, analysis cams, motion of rigid bodies in two dimensions, vibration and deflection of beams. Numerous examples are worke out in the text. It is recommended that the student wor through as many of the exercises as possible.

Air Conditioning Analysis with Psychrometric Chart and Tables. By William Goodman. Size 6½ by 9½ in 455 p.; cloth binding. Published by The Macmillan Co 60 Fifth Ave., New York, N. Y. Price $6.

This book is intended to cover a comprehensive, unifie treatment of the fundamentals of the science of changin the condition of air, which has not heretofore been compile in one place, excluding such elements as refrigeration, ai handling and temperature control. Psychrometric charts with the very fundamental coordinates of enthalpy an specific humidity are presented for a wide range of tem peratures, the use of which greatly simplify the analysis of air conditioning processes by basic thermodynami methods. There is no other way in which air conditioning processes can be visualized so clearly and simply as on th psychrometric chart and the chart lends itself admirably to quick graphical computations, eliminating much tedious arithmetic. For these reasons, the psychrometric chart is discussed in detail and the solution of many types of air conditioning problems likely to be encountered in practical work are illustrated on it.

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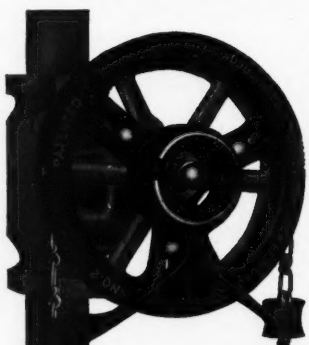

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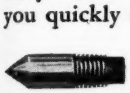
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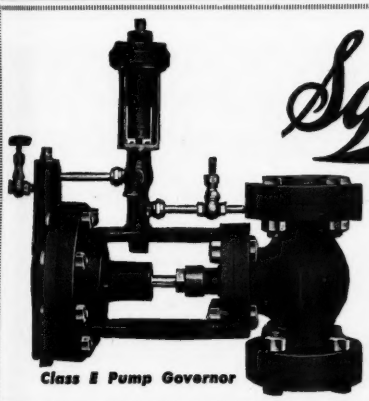
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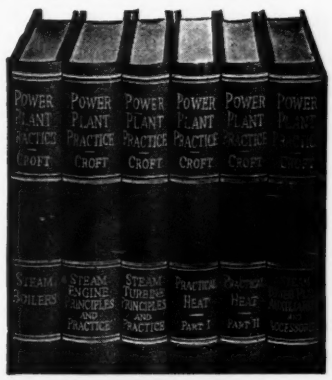

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Power Plant Construction News

Calif., Los Angeles—Rheem Mfg. Co., 4361 Firestone Blvd., South Gate, Los Angeles, manufacturer of steel tanks, drums, etc., plans installation of electric power equipment in connection with expansion in plant for production for Government. Entire project will cost close to $200,000, with financing by Defense Plant Corp., Washington, D. C., Federal agency. Work is scheduled to be carried out soon.

Calif., Santa Monica—Douglas Aircraft Co., Inc., 3000 Ocean Park Blvd., Santa Monica, plans installation of power equipment in connection with expansion in plant in California, exact location not announced, for production for Government, including new buildings and machinery for large increased output. Entire program will cost about $3,890,000, and will be financed by Defense Plant Corp., Washington, D. C., Federal agency.

Conn., Stratford—Vought-Sikorsky Division, United Aircraft Corp., 550 Main St., manufacturer of airplanes and parts, plans installation of electric power equipment in new one-story addition on South Ave. Cost reported over $85,000, with machinery. Work is scheduled to begin soon. Albert Kahn Associated Architects & Engineers, Inc., New Center Building, Detroit, Mich., is architect and engineer.

Fla., Jacksonville—United States District Engineer Office, Jacksonville, plans installation of power equipment in three new aircraft engine repair and maintenance shops on sites in Dade County, exact locations not announced. Entire project will cost about $1,000,000, and will be carried out at early date.

Ind., Indianapolis—Bridgeport Brass Co., operating an ordnance plant on South Holt Rd., Marion County, vicinity of Indianapolis, for production for Government, plans installation of electric power equipment in new one-story addition, estimated to cost close to $1,000,000. Financing will be provided by Defense Plant Corp., Washington, D. C., Federal agency. Work will begin soon.

Indiana—Youngstown Sheet & Tube Co., Youngstown, Ohio, manufacturer of steel pipe, tubing, etc., plans installation of electric power equipment in connection with expansion in plant in Indiana, exact location not announced, for production for Government. Work will include new building and machinery installation for increased output. Cost estimated about $1,200,000, with financing by Defense Plant Corp., Washington, D. C., Federal agency.

Iowa, Iowa Falls—Commodity Credit Corp., Department of Agriculture, Washington, D. C., plans boiler house at proposed new hemp-processing plants at Iowa Falls, with installation to include a 400-hp. boiler unit and auxiliary equipment. Also will install a 150-ft. dryer tunner above ground. Plant will consist of several one-story buildings and is reported to cost close to $350,000. Proposed to begin work soon. A similar plant is projected at Britt, Iowa, to cost approximately a like amount.

Iowa, Mount Vernon—City Council plans installation of new deep-well turbine pumping unit and auxiliary equipment for water supply system, to replace worn-out machinery. No estimate of cost announced. Application has been made for a preference rating, and purchase is scheduled to be made soon.

Kansas—War Department, Washington, D. C., has approved plans for expansion in army air force base in Dickinson County, exact location withheld, comprising shops, warehouses and other industrial buildings, with installation of electrical equipment and other facilities, including power substation apparatus. Complete project is estimated to cost close to $2,000,000, and will be carried out under direction of United States District Engineer Office, 10 East Seventeenth St., Kansas City, Mo.

Mich., Sault Ste. Marie—Bye Fuel & Ice Co., Sault Ste. Marie, has plans under way for new one-story ice-manufacturing plant on East Portage Ave., about 32x80 ft., with cold storage department, 32x32 ft. Cost reported close to $40,000, with equipment. Work is scheduled to begin at early date.

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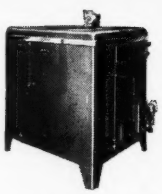

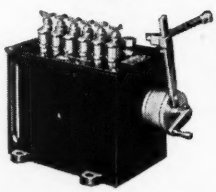

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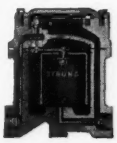

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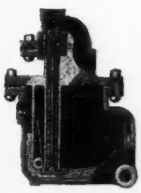

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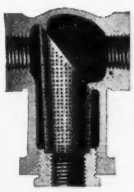

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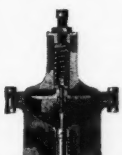

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Michigan — General Motors Corp., General Motors Building, Detroit, plans installation of electric power equipment in connection with expansion in certain plants in Michigan, exact locaton not announced, including new buildings and additional facilities for increased capacity for Government. Entire project will cost about $3,500,000, with financing provided by Defense Plant Corp., Washington, D. C., Federal agency.

Minn., Winona—Water Board will receive bids on or about April 8, for conversion of boiler plant at municipal waterworks from oil to coal fuel, including installation of stoker and auxiliary equipment. No estimate of cost announced.

Neb., Lincoln — Lincoln Packing Co., plans installation of electric power equipment in new one-story addition to meat-processing and packing plant. Cost reported close to $40,000, with machinery. Work will proceed at early date. A priority rating is being secured.

N. J., Garfield—Accurate Mfg. Co., 44 Hepworth Pl., Garfield, manufacturer of rubber insulating tapes, etc., plans new boiler house at plant. Cost reported close to $35,000, with boiler unit and auxiliary equipment. A. E. Rigolo, 699 Main Ave., Clifton, N. J., is architect.

N. J., Perth Amboy—Board of Governors, Perth Amboy General Hospital, Groom and Lawrie Sts., plans installation of new boiler plant for central-heating service in connection with new addition to institution. Entire project will cost about $250,000, of which $101 000 will be a Federal grant. Proposed to secure a preference rating and carry out work soon.

N. J., Perth Amboy—Titeflex Metal Hose Co., 500 Frelinghuysen Ave., Newark, N. J., manufacturer of flexible metallic tubing, plans installation of electric power equipment in new plant on State St., Perth Amboy, comprising former works of American Encaustic Tiling Co., totaling 110,000 sq. ft. of floor space, which has been secured under lease. Work is scheduled to begin soon. No estimate of cost announced.

Ohio, Newark—Water and Light Department is considering extensions and improvements in municipal power plant, including installation of new steam turbine unit and auxiliary equipment, reported to cost close to $90,000. It is understood that application will be made for a priority rating.

Okla., Taft—State Board of Public Affairs, Capitol Building, Oklahoma City, Okla., has tentative plans for new power house and mechanical-laundry at State Training School for Negroes, Taft, reported to cost about $70,000, with equipment.

S. D., Sioux Falls—State Department of Education, Pierre, plans improvements in boiler house used for central-heating service at School for Deaf, Sioux Falls, with installation of stoker and accessories. No estimate of cost announced. Appropriation is being secured.

Texas, Athens—New Era Electric Cooperative, Inc., Athens, plans construction of transmission and distributing lines in parts of Anderson, Smith, Henderson and Van Zandt Counties, totaling over 200 miles, with power substation facilities and service connections. Entire project will cost in excess of $250,000, and is scheduled to begin soon.

Texas, Dallas—Universal Cor 2100 North Harwood St., manufactur of metal building products, plans i stallation of electric power equipme in new plant on 5-acre tract of lan at Denton Dr. and Maple St., consis ing of two main one-story building 100x435 ft., and 100x105 ft., respe tively, and auxiliary structures. Co reported in excess of $160,000, wi machinery. Work is scheduled to beg soon. Walter H. Ahlschlager, South land Life Building, Dallas, is architec

Texas—Dow Magnesium Co., Mid land, Mich., an interest of Dow Chemi cal Co., same address, plans installa tion of electric power equipment i connection with expansion in magne sium plant in Texas, exact location no announced, for production for Govern ment. Facilities will be installed fo increased capacity. Cost estimate about $335,000, with financing provide by Defense Plant Corp., Washington D. C., Federal agency.

Wis., Cambridge — Melster Candy Co., is having plans completed for new boiler house at factory, with installation of boiler unit and auxiliary equipment. No estimate of cost announced. Proposed to begin work soon. Law Law & Potter, 121 South Pinckney St., Madison, Wis., are architects.

Wis., Delavan—Thomas B. Gibbs Co., Delavan, manufacturer of electronic apparatus, plans installation of electric power equipment in new one and two-story addition, about 80x330 ft., reported to cost over $150,000. Work on superstructure will begin soon. Holsman & Holsman, 140 South Dearborn St., Chicago, Ill., are architects. Company is affiliated with George W. Borg Corp., 469 East Ohio St., Chicago.

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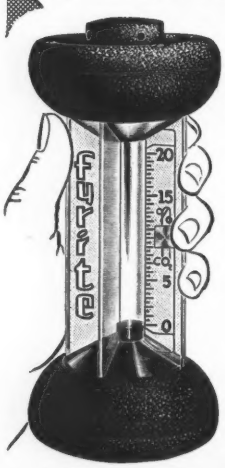

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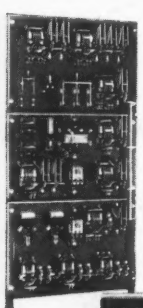

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